Compressed Air Magazine

VOLUME 47 • NUMBER 7 JULY 1942 LONDON • NEW YORK • PARIS

Engineering Library

SHASTA DAM CABLEWAY RIGGERS

Because this Thorobred has a Fighting Heart...

YOU GET AS MUCH AS 41% LONGER LIFE

Beneath the tough, sleek, black coat of the Dayton Thorobred Wrapped-Molded type V-Belt, there is a fighting heart of Daytex Cord—a heart built right into the Thorobred with its three prime sections (a construction principle pioneered by Dayton). The test evidence of the extra long life that the Dayton Thorobred gives you, as contrasted to other leading belts, is shown on the chart reproduced here. But the very best evidence of the Thorobred's performance is the hundreds of field applications in many important industries. These applications prove beyond question that the Thorobred is everything that its name implies.

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Dayton, Ohio

DAYTON RUBBER EXPORT CORP.
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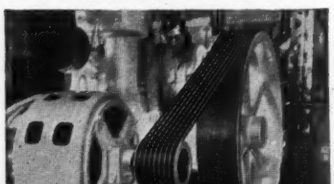
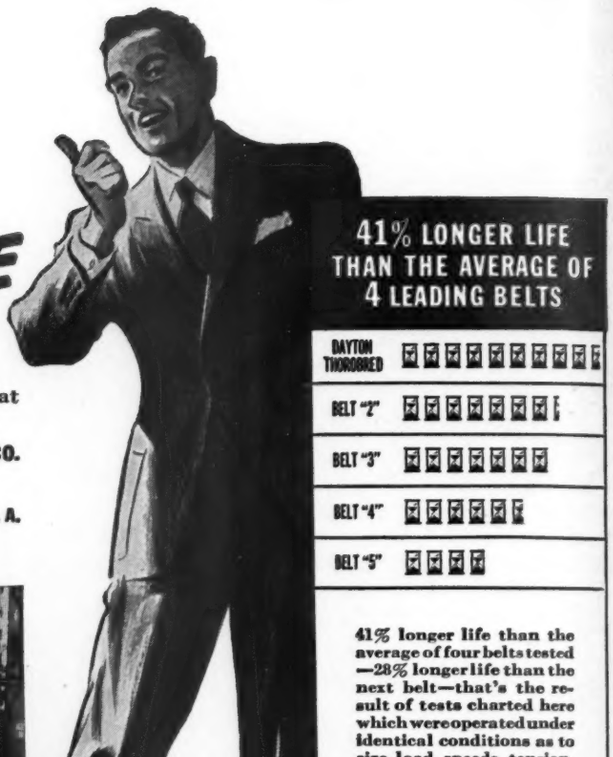
THE WORLD'S LARGEST MANUFACTURER OF V-BELTS




41% LONGER LIFE THAN THE AVERAGE OF 4 LEADING BELTS
DAYTON THOROBRED
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BELT "3"
BELT "4"
BELT "5"
41% longer life than the average of four belts tested —28% longer life than the next belt—that's the result of tests charted here which were operated under identical conditions as to size, load, speeds, tension, pulley diameters and ambient temperatures.

Dayton Thorobred V-Belts

3 PRIME SECTIONS

Under the tough, rugged black cover which resists dust, moisture and other elements, are Dayton's 3 prime sections.

1. **THE TENSION SECTION**—Live, heat-resistant compounds provide the "give" necessary to efficient and cooler-running performance.

2. **THE DAYTEX CORD NEUTRAL SECTION**—The fighting heart of the Thorobred—famed Daytex Cord imbedded in strong, live compounds.

3. **THE COMPRESSION SECTION**—Fibres run crosswise to achieve great cross-sectional rigidity, less distortion in pulley grooves.

Dayton V Belts

LIFELINES OF POWER VITAL TO VICTORY

ON THE COVER

OUR cover picture shows riggers at Shasta Dam working on an aerial cableway high above the ground. The tool is a No. 534 air-operated impact wrench and is being used to run up nuts on Crosby clips—patented cable fastenings. The track cable, on which the carriage wheels run, is of the locked-coil type, which gives it a smooth exterior surface. It is 3 inches in diameter, is made of 175 individual wires, and sells for approximately $6 a foot. The photograph is reproduced by courtesy of the American Hoist & Derrick Company.

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IN THIS ISSUE

AN ARTICLE by Henry W. Young brings readers up to date on the construction of Shasta Dam, second largest masonry structure of its kind ever undertaken. It also gives essential information regarding Keswick Dam, a sizeable barrier in itself but one that has been relegated to the background because of its contiguity to Shasta. Previous articles concerning Shasta Dam appeared in our September, 1939, and October, 1940, issues.

•

COLORADO has been known chiefly as a gold- and silver-producing state, but it also contains commercial deposits of many other metals. The war has given a fillip to lead and zinc mining at Rico, a small camp deep in the heart of the San Juan region that has had a checkered history. Current activities of one of the larger companies now operating there are described in our second article.

•

MUCH practical information on the efficient use of air-operated tools will be found in the article starting on page 6790. The curves and tables accompanying it are based on actual shop tests.

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THE production of aluminum is so vital to the war effort that the story of how the Aluminum Company of America is expanding its operations is pertinent information. Moreover, it is interesting reading.

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CANADA marshals its census statistics into usable form with the aid of an ingenious mechanical tabulator that is operated by compressed air. The facts we present concerning it came directly from the holders of the patent rights.

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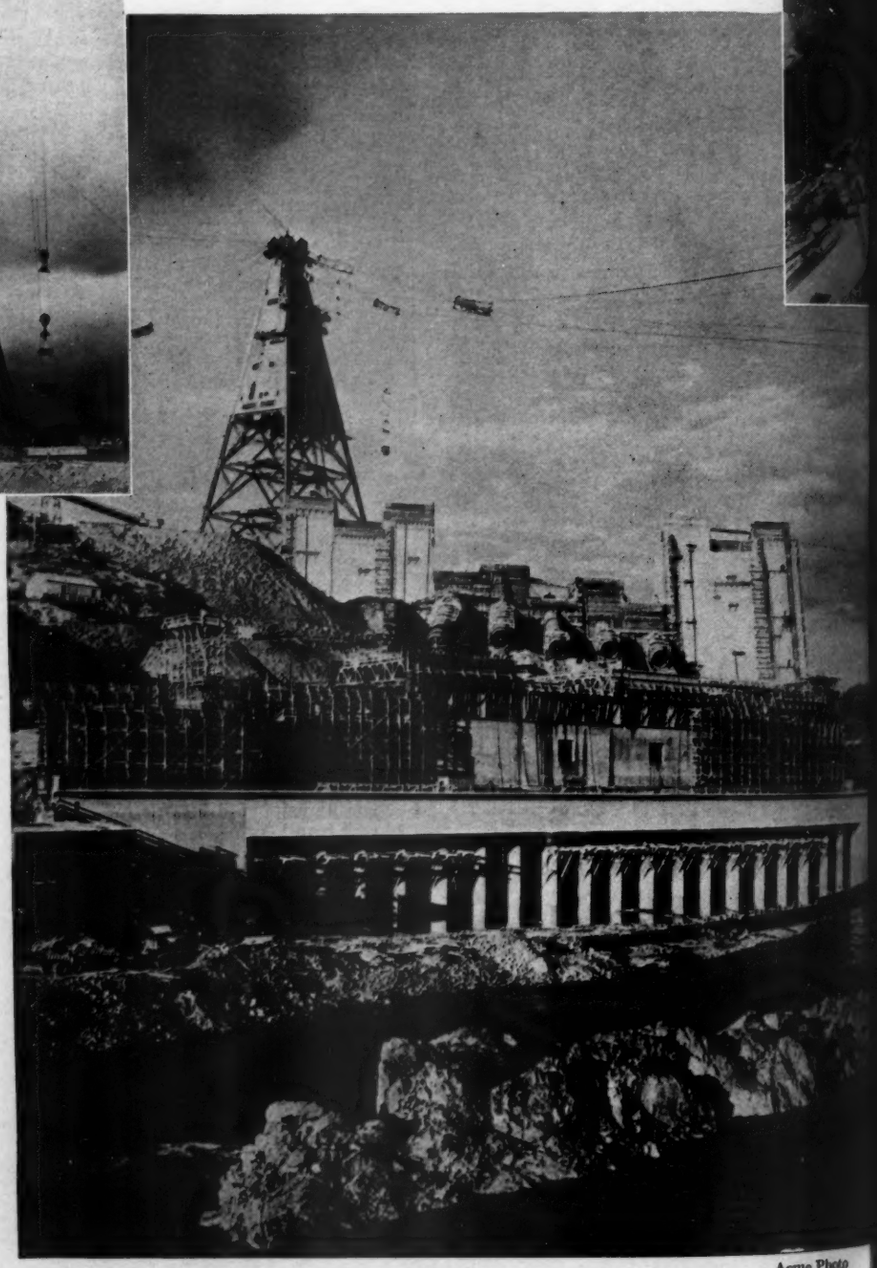
Shasta and Keswick Dams

Henry W. Young

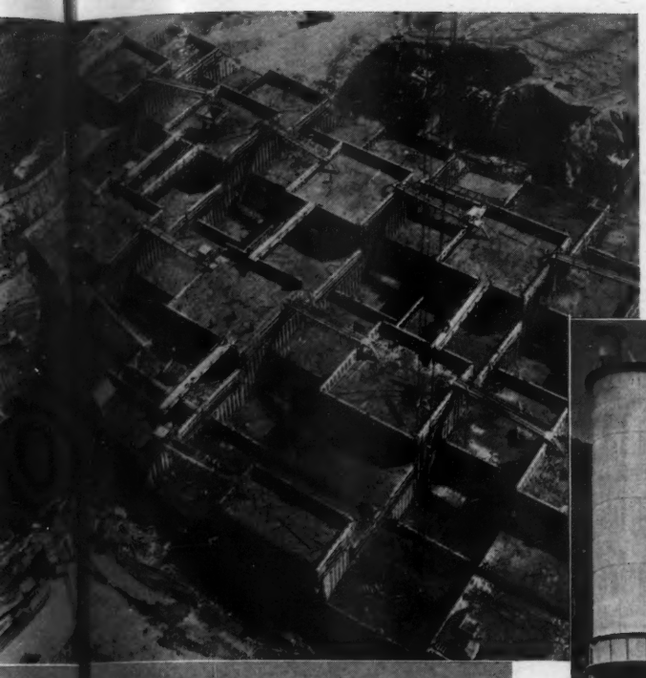


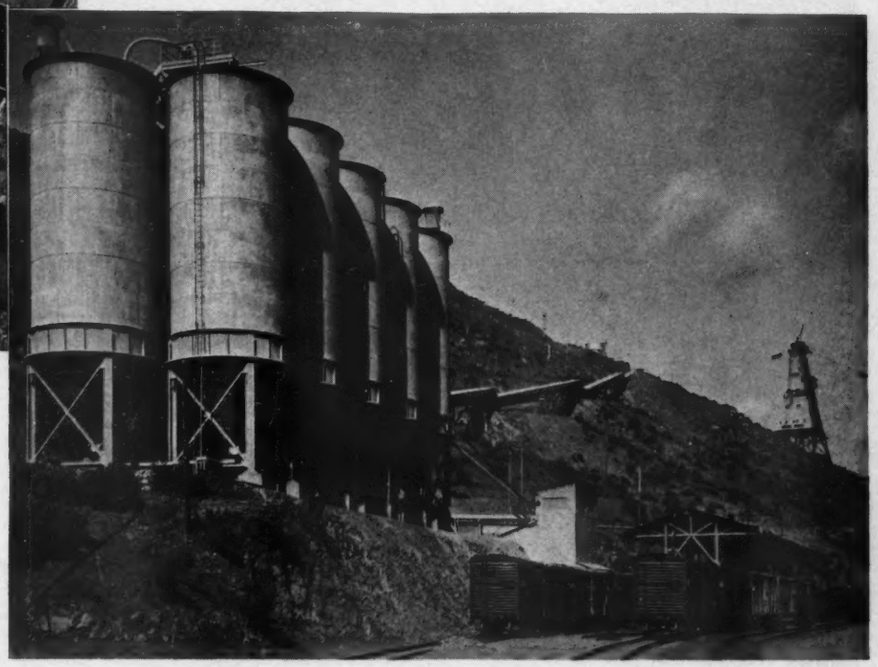
Acme Photo

MOVING along according to schedule, Shasta power plant and dam, the world's second largest masonry barrier, reached the halfway mark on March 30 when 3,000,000 of the more than 6,000,000 cubic yards of concrete had been placed. Within the past two years articles have appeared in this magazine telling of the power-producing, water-controlling features of the U. S. Bureau of Reclamation's far-reaching Central Valley Project in California, of which Shasta Dam is the main feature. They described how the great structure will impound 4,500,000 acre-feet of water; how this water will be fed back into the Sacramento River under conditions of controlled flow, produce 375,000 kw. of electrical energy, and stabilize the flow of that stream, thus preventing annual disastrous floods; how excess water will be used for irrigation and for holding back saline encroachments in the rich delta region; and, finally, how power from Shasta is to be distributed over a 200-mile transmission system for pumping the irrigating water and for industrial purposes, including a number of new war-production plants.

Working under a materials priority rating of A-1-e for all construction, railroad relocation, and reservoir clearing, the job is to be completed late in 1943 or early in 1944. At that time the powerhouse will be equipped and ready for service. That is already assured by congressional appropriations. Funds for continuing the transmission line and for a proposed auxiliary steam plant that will supplement the hydroelectric energy generated at Shasta, and thus make it possible to supply firm power, have not as yet been authorized.

Located in the Pacific combat zone from which all Japanese are being evacuated for the duration of the war, the region around Shasta Dam is likewise to have a peaceful evacuation. Preparations already are being made to move the entire population of Kennett, which is situated a few miles upstream within the reservoir area. In its heyday as a copper-mining camp it had 1,800 inhabitants; but in recent years the number has dwindled to about 150.





SHASTA DAM TAKES FORM

More than half the 6,000,000 cubic yards of concrete that will make Shasta Dam the second largest man-built structure of its kind has been poured, and the barrier now appears as shown in the center. In the foreground is the powerhouse, and above it are the ends of the five 15-foot penstocks that will convey water to the 75,000-kw. generators. Rising at the left is the 460-foot-high head tower of the radial cableway that handles concrete and other materials. It is seen in greater detail at the upper left. Cement is stored in silos (below) and blown from them half a mile uphill to the concrete-mixing plant at the head tower. The other picture shows the pattern of the concrete blocks which are poured in 5-foot lifts of four 15-inch layers.

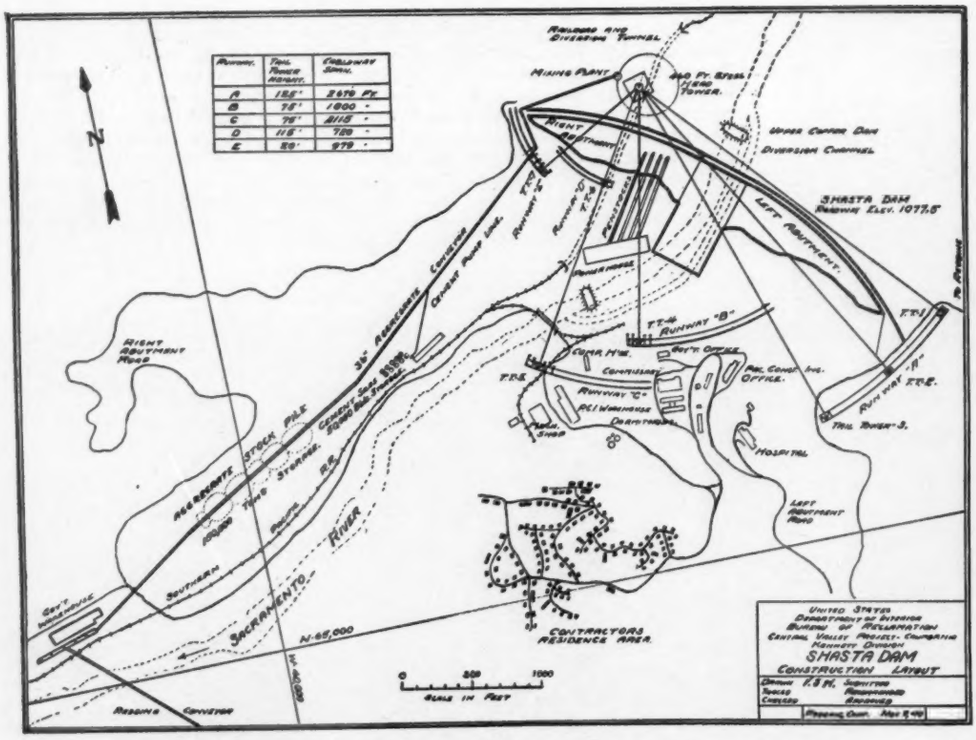
Acme Photo

If the buildings of this ghost town are considered worth salvaging, they will be wrecked by the Government and disposed of. If not, everything floatable will be burned.

Progress on the relocation of the railroad and highway from the river canyon to high ground beyond the reach of the waters of the reservoir has kept pace with dam construction. The extent of this work can best be understood by examining the accompanying map. The new railroad line, beginning at Redding, is several miles to the east of the tortuous canyon and is approximately 30 miles long, as against 37 miles for the old route. Besides shortening the run by 7 miles, it eliminates 5,000° of curvature, the equivalent of about fourteen complete circles. The highway—U.S.99—involved less relocation, the latter starting about 12 miles north of Redding near the southern approach of the new Pit River Bridge. It will be opened to traffic later this year. While the Bureau of Reclamation pays for the work "in kind," the California State Highway Department handles the contracts and pays for any additional improvements as to width, alignment, etc., that it may choose to make.

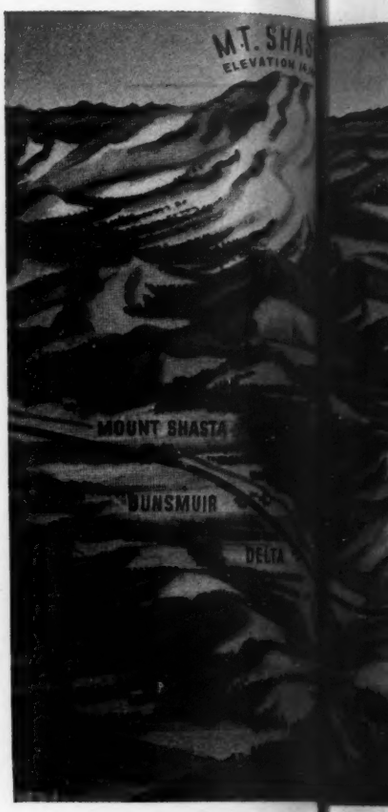
Rather unceremoniously, on Sunday March 15, the new railroad was dedicated by the passage of the first regularly scheduled train—a Southern Pacific southbound freight. At the present time the tracks are being used by all southbound freight trains and all passenger trains moving in both directions, while northbound freights, climbing up the mountains, will continue to travel the old route until the water- and fuel-supply systems are completed. The work of relocation entails the driving of twelve tunnels and the building of eight major bridges, among which is the Pit River Bridge with two railroad tracks on the lower deck and a 4-lane highway on the upper one, which is 500 feet above the present river level. The span, including short viaduct approaches at each end, is 3,588 feet long and is carried on concrete piers which are said to be the world's highest for a bridge of this type. When the reservoir is filled they will be submerged to within 35 feet of the top; but, for a time, motorists will have the thrill of passing over a free-standing structure higher than any other in California.

The entire project has involved more than 4,000,000 cubic yards of excavating to grade the roadbed, the driving of 19,000 feet of tunnels, the erection of 29,000 tons of structural steel, and the laying of 6,000 tons of rails. While the construction of Shasta Dam and the relocation of the railroad have been underway for the last 3½ years, train traffic on the old line has been carried past the dam site through a tunnel that was driven under the west abutment. The Sacramento, in the meantime, has continued to flow past the site in its natural channel, or in temporary diversion channels. After the tracks in the canyon upstream from the dam are



SHASTA CABLEWAY SYSTEM

Radiating from the head tower are seven cableways, each extending to a tail tower that moves on a runway. The three longest lead to track A, and each has a reach of 2,670 feet. Collectively, they cover every part of the construction area.



From S

abandoned this summer, the midsection of Shasta Dam will be poured and the river will be diverted through the tunnel now used by the railroad.

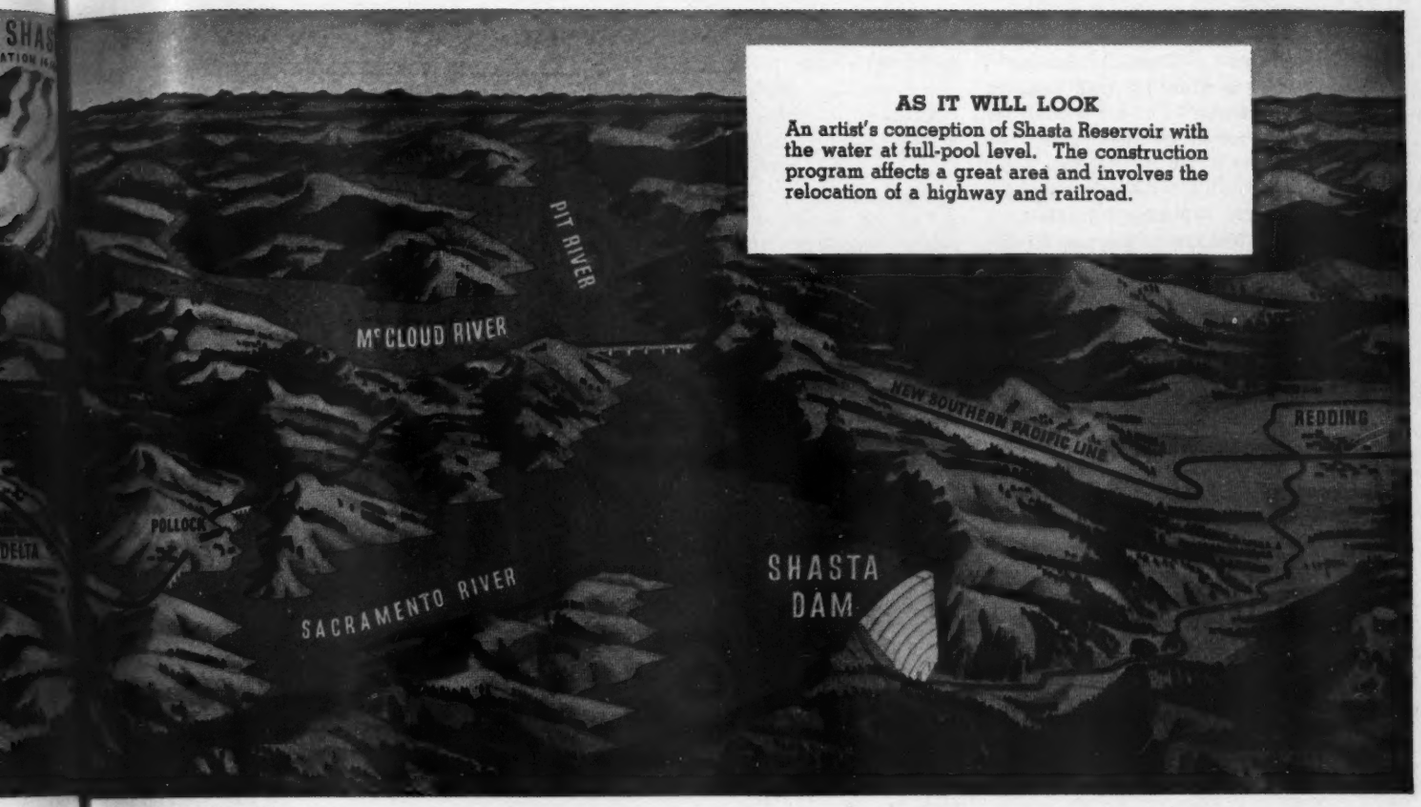
How the contractors, the Pacific Constructors, Inc., have gone about building Shasta Dam has already been covered in these pages. Reviewed briefly, it was necessary first to bore the tunnel in the west bank to carry the Southern Pacific traffic until the completion of the railroad relocation. This was done under contract by the Colonial Construction Company. When this tunnel, with its control gates, is no longer required for diversion purposes it will be plugged. Excavating for the dam and its abutments began at about the same time, all classifications amounting to approximately 3,250,000 cubic yards. With only a comparatively small quantity of muck to be removed from the river channel, the problem was one of excavating the steep hillside down to solid material with shovels and 15-cubic-yard dump trucks and then drilling the rock for the dam and abutment foundations. The spoil was classified, that not used for raising embankments upstream adjacent to the abutments was wasted. For the rock work, wagon drills were employed on a larger scale than ever before, no less than 42, for the most part of the Ingersoll-Rand FM-2 Type, being in service at one stage. These machines drilled holes up to 2¾ inches in diameter and 24 feet deep, averaging 200 feet per drill per shift of 6 hours and 40 minutes.

In the meantime, preparations were made to secure the 10,400,000 tons of aggregates for the concrete. After surveying all possibilities, a bed near Redding was selected and a contract awarded by the Bureau of Reclamation to the Columbia Construction Company, Inc., to process and deliver the materials at Coram, about a mile downstream from the dam site. How this is being done with a 10-mile belt-conveyor system has been fully described in the October, 1940, issue. Transportation of aggregates on construction jobs by long traveling belts was initiated at Grand Coulee; but at Shasta, with distances multiplied by ten, the idea was carried out on such a large scale that the conveyor system will go down in engineering history as a milestone.

From the Coram bunkers, having a capacity of 150,000 tons or about one week's supply, Pacific Constructors, Inc., are transporting the aggregates by another belt system a distance of 7,250 feet to a conventional-type mixing plant which has a daily output of more than 10,000 cubic yards. It consists of five 4-yard mixers and a Johnson batching system, and the order of mixing is fully automatic. A 420-foot-diameter circular track or endless railway delivers the concrete in steel cars to the various landings of the "hi-line" buckets. While not unique, the method of distribution throughout the dam site by hi-line radial cableways—from head tower to movable tail towers—is outstanding because of its magnitude. The central feature is a head tower 460 feet high from ground level. The four legs, on a 185-foot square, are anchored 102 feet below the surface. Including the mast of the pillar crane, the structure has a total height of 610 feet and contains approximately 4,180 tons of structural steel.

The accompanying diagram, furnished through the courtesy of the Bureau of Reclamation, shows the whole construction layout. It will be seen that the radial cableway system with its seven hi-lines is operated in connection with five tail-tower tracks—A, B, C, D, and E—by means of which it is possible to reach every part of the dam. The 2,670-foot lines to the A Runway are the longest and will place about two-thirds of the concrete with 8-cubic-yard buckets. The hoisting equipment has a speed of 300 feet per minute with a 20-ton working load, and the carriage speed is 1,200 feet per minute. The buckets are rectangular in shape, the bottom forming two hinged gates. Discharge is controlled by the head-tower operator through two hoist lines; but before the contents can be dumped, the concrete crew has to undo the two safety latches with which each container is provided. Spotting of the buckets is done by the aid of phone and signalmen, but short-wave radio can be used in place of the telephone.

The diagram also shows the location of the cement silos near the aggregates stock piles. The silos have a capacity of 55,000 barrels, and the material is blown to the mixing plant through pipes by means of a Fluxo plant using compressed air. At this stage of the operations the latter is one of the largest consumers of air on the proj-



AS IT WILL LOOK

An artist's conception of Shasta Reservoir with the water at full-pool level. The construction program affects a great area and involves the relocation of a highway and railroad.

From Southern Pacific Company

ect. It is characteristic of this job, as of other similar ones, that more and more air is required as the work progresses, whereas with the rock drilling about finished, it might be assumed that consumption would fall off. The original compressor installation at Shasta includes four machines of 2,650 cfm. each. Then another of 1,000 cfm. was added, bringing the total to 11,600 cfm. This does not take into account three I-R portables of 315 cfm. each.

The concrete blocks are placed in 5-foot lifts of four 15-inch layers. Preliminary to pouring a lift, the surface of the underlying one is cleaned by the usual high-pressure air-water-sand blasting method, the excess water being removed by sponges. Next, a layer of grout is spread and brushed over it. Concrete with a slump of approximately 1¾ inches is used. It is compacted with 6-inch electric and pneumatic vibrators and water cured—the contraction joints and faces being treated for 21 days by a sprinkler system. The first concrete was placed in the left abutment on July 8, 1940, and in the powerhouse on August 26 of the same year, the highest record made so far being 11,800 cubic yards in one 24-hour run. The aim is to adhere to an 8,000-yard-per-day schedule during the dry months.

A complete grout and cooling pipe system is installed before each lift is poured, and after the concrete in the dam has reached the required temperature, all joints between blocks are grouted under high pressure. Underneath the dam is the usual system for shallow and deep grouting so as to fill every possible crevice in

Photo by Claude Ferguson

PIT RIVER BRIDGE

This double-deck cantilever structure has four highway lanes on the upper deck and two railroad tracks on the lower one. As built, it rises 500 feet above the river, but when Shasta Reservoir is at full-pool level it will have a clearance of only 35 feet above mean high water. This picture was taken on a stormy day during the construction period and shows clouds below the deck structure. Also visible are the nets that were provided to prevent workmen and tools from falling to earth.

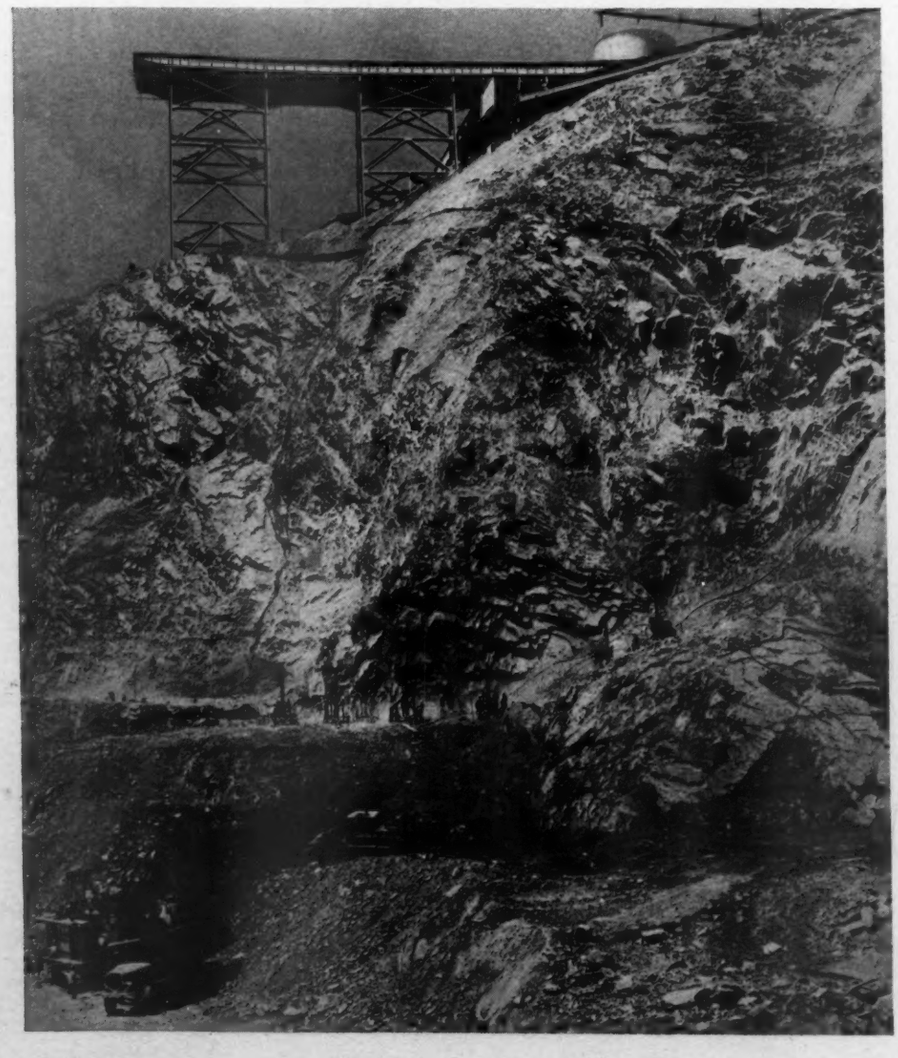
the foundation rock and thus form an impervious screen extending far beneath the dam and abutments. Diamond drilling of the grout holes is done by Dan Longtin under a subcontract. The holes used for initial grouting are 30 feet deep, and these are followed later by 75- to 100-foot holes upstream. Last of all, holes are drilled for the purpose from drainage tunnels to a depth of 100 to 300 feet. Pressures for the work vary from 30 up to 1,000 pounds per square inch. Before the dam is completed, eighteen 102-inch steel conduits will be installed to serve as outlets for the river.

Contracts for machinery and material, totaling $10,785,749, have been awarded in the meantime. These include five 75,000-kw. generating units, sixteen transformers with electrical control equipment, two small-station service generators, five steel penstocks, and three 25,000-kw. generating units for the Keswick plant that is being constructed 9 miles downstream from Shasta. A contract for three 25,000-kva. transformers for Keswick will be let later. The first two Shasta generators, ordered in 1939, have been built and shipped, each in 35 railroad cars. Some of the smaller parts are in a warehouse at Shasta, while the large machines were stored at Boulder Dam pending the completion of the Shasta powerhouse with its overhead cranes for handling them. In preparation for the setting up of the electrical machinery by the Bureau of Reclamation, a shop has been erected at Shasta at a point on the west bank just downstream from the power plant.

Pouring of the concrete for the Shasta powerhouse is about finished. Steel-plate liners for the No. 4 Turbine pit were the first items to be assembled and were in place by March 1 of this year. At the same time work was started on the liners for No. 5 Turbine pit, to be followed in sequence by Nos. 3, 2, and 1. These draft tubes are at the base of the power station and will discharge water from the turbines back into the river. The five hydraulic turbines, each of 103,000 hp., will be connected by vertical shafts to the generators above. The installation of the first two generators began in May; the three others are now in course of manufacture in the East. All five penstocks are well underway—the upper sections are embedded in the dam and the lower ones are approaching the powerhouse.

The construction and laying of the welded penstocks are interesting procedures, fabrication of the units being done by the Western Pipe & Steel Company at a plant built at Coram. The work is under the supervision of Gilbert Yetter, Bureau of Reclamation engineer in charge of manufacturing and installation, and of A. Wright, superintendent for the contractor, the Western Pipe & Steel Company. The plates, of flange-quality boiler steel, are cut to shape, rolled into circular form, and beveled variously, depending on the weld, before delivery at Coram. There the rings are squared up on jigs and the joints fitted and tack welded, after which are inserted spiders or spreaders to keep them round during welding. They are then put on rubber-tired roller supports and the longitudinal seams welded in double-V grooves, the angle varying with the plate thickness. They are welded both inside and outside, each time in one pass, with an automatic machine. In the case of the heaviest plates, preheating is resorted to.

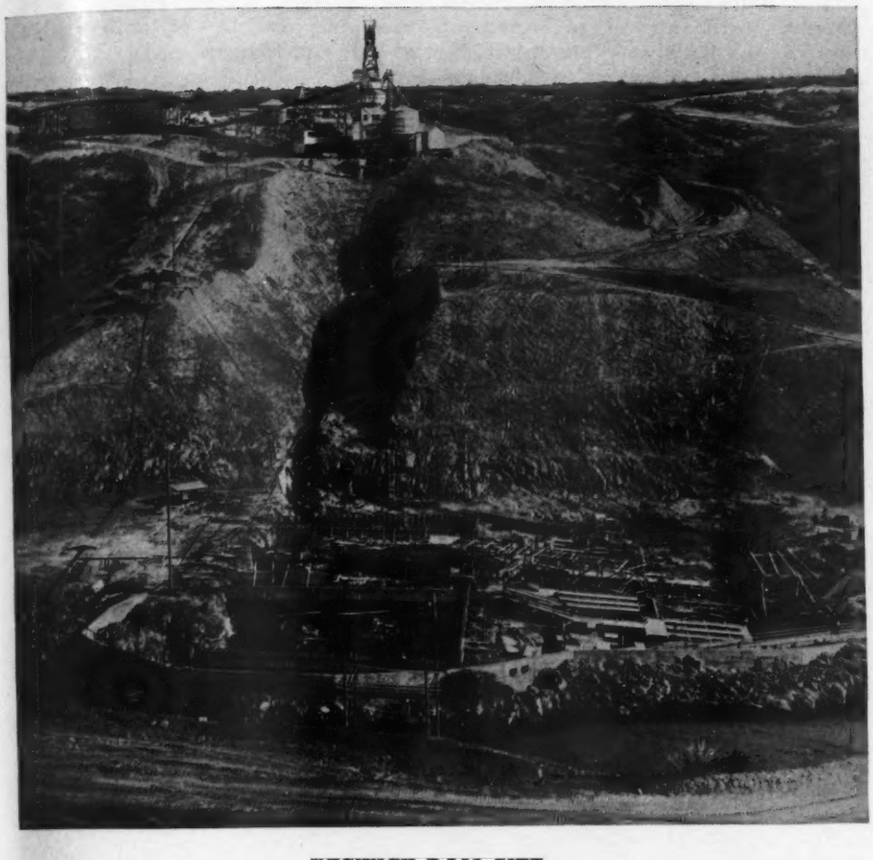
Two rings constitute a standard section, which is 20 feet long and 15 feet in



Acme Photo

EXCAVATING CONTINUES

Although concrete pouring has been going on at the lower levels for months, the work of removing weathered rock still proceeds at the Shasta abutments. At the left are shown ten wagon drills working on a bench on the west side of the valley. These powerful machines do most of the drilling, but Jackhamers serve in the less accessible areas. Joe O'Brien is the operator who adopts cowboy tactics in guiding a JA-55 drill in a rather precarious location (above).



KESWICK DAM SITE

This structure is rising 9 miles downstream from Shasta, for which it will provide afterbay regulation. Keswick will be 132 feet high, 1,000 feet long at the crest, and will generate 75,000 kw. It will include a fish trap as a part of the Government's salmon-conservation program. Its cableway system has towers of wood, no steel being available for the purpose at the time they were erected.

diameter. However, where curves are involved, special sections are made up of several properly formed smaller units. Preparatory to joining, the rings are mounted on rubber-tired supports on a table equipped with a Link-Belt automatic rotating machine; the spiders are taken out; and the edges of the rings are butted together so as to stagger the longitudinal seams. The work is next revolved while the welding-machine arc, buried in flux, closes the circumferential seam in one pass. Where preheating is required it is done by a stationary torch that is trained on the under surface and slightly ahead of the arc as the section turns. The two rings are held together during welding by an air-operated riveter mounted so that the pressure exerted by it will keep the edges in alignment. Any notable surface defects discovered after welding is completed are repaired manually. Then all seams are ground down to 1/16 inch of flush, inside and out. As a result of this smoothing down there seems to be a sharper contrast between weld and plate in the X-ray photographs that are taken of every foot of seam in the sections that make up the five penstocks, aggregating nearly a mile in length.

The X-ray machine is portable and adjustable and uses 4½x17-inch negatives. The section to be photographed is laid out and given location marks corresponding to those on the identical section in drawings of the penstocks. Lead numbers on the cassette appear in each photograph, so that the picture of any part of any seam in the penstocks can be picked out of the files in which they are kept. When a defect shows up at any point, the metal is removed by chipping and that part is rewelded manually, after which it is ground and again X-rayed. The negative is filed for reference, provided the weld is satisfactory. In determining whether the welding is good or not, the films are all compared with a set of standard, permissible-defect films issued by the A.P.I., A.S.M.E.

The section is now ready to undergo a stress-relief process in an annealing furnace where it is heated to 1,100-1,200°F. for one hour for each inch of thickness. In cooling, the temperature is prevented from going below 500° within a 3-hour period, at the end of which it is allowed to drop to normal. Finally comes a hydrostatic test with pressures varying from 185 pounds per square inch for the uppermost sections to 550 pounds for the lowest ones. For making field hydrostatic tests a head is welded in the upstream-end sections, while the lower ends have riveted heads.

From the plant at Coram the completed sections are transported by a 50-ton trailer to the powerhouse where they are within reach of the hi-line cableway that puts them into position in the respective penstocks for welding. There, Teleweld, Inc., of Chicago takes over the welding under a subcontract. All the work is done by manual arc welding with heavily covered steel electrodes. The welds are made, finished, and also X-rayed, but with the film held on the outside and the portable X-ray tube on the inside, the reverse of the shop practice. All the X-ray photography is done under another subcontract by the Industrial X-Ray Laboratories, Inc., Seattle, Wash.

Inside the dam, where the penstocks are encased in concrete, there are contraction joints every 50 feet from the axis of the structure to the face. Wherever the embedded part of a penstock crosses a contraction joint a slip joint is provided, and all these are later welded from inside the penstocks after the contraction joints have been grouted. This welding is done by a controlled procedure, and after a seam is completed it is magnetically tested by the Magnaflux method. For the most part, the sections that make up the penstocks are of standard length and diameter. Those buried in concrete at the top, where the pressure is lowest, are thinnest, weighing 28 tons, while the heaviest ones at the bottom weigh approximately 72 tons.

Compressed air plays an important part in the fabrication of the penstocks, and to meet the demand the plant has its own compressor and air-operated tools and equipment. Aside from the rivet hammer already mentioned, I-R No. 534 impact wrenches are used for tightening the heads that must be placed at the ends of each section for the hydrostatic test. Then there are I-R wire-brush machines for cleaning surfaces, Type 3F grinders for grinding down the welds before X-raying, chipping hammers for repair work, peening tools, D6U and HUL hoists for turning the sections during welding, and pneumatic equipment for cleaning the inside surfaces of the sections before transferring them to the dam.

No description of Shasta dam at this time would be complete without reference to Keswick Dam, which is being built by the Bureau of Reclamation to provide an afterbay regulating reservoir, with a storage capacity of 10,000 acre-feet, for the great Shasta power plant. It will generate an additional 75,000 kw. of electric power and also will include fish-trapping facilities in accordance with the Sacramento River salmon-rehabilitation program. The dam will be about 132 feet high, from the lowermost rock to the top of the roadway, and 1,000 feet long.

The present contract, covering construction of the base of the structure and excavation for a 1,500-foot railroad bypass, was awarded on August 9, 1941, to the Atkinson Kier Company on a bid of

$2,736,628, which was the lowest of three submitted. This is for construction only, the Bureau of Reclamation, as usual, furnishing the materials. The contractor has 500 calendar days in which to complete the work after receipt of an official notice to proceed; but, anticipating the date of its arrival, he was on the job with a crew of 350 men by mid-August, 1941. It was a race with the forthcoming winter rains—the aim, in which the contractor succeeded, being the placement of concrete east of the fish-trap section of the dam to flood-limit height before high water could restrict operations on the lower section of the structure.

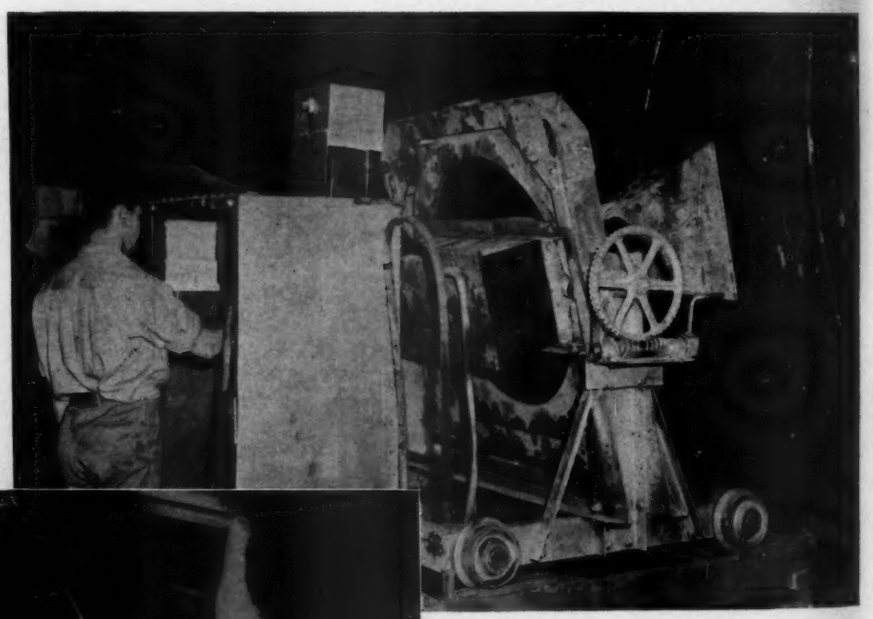
The dam is being built in two stages to avoid the necessity of expensive railroad relocation between Keswick and Shasta Dam. The present specifications cover only the first stage and include excavation of the foundation; construction of the base of the spillway section, powerhouse, and abutments to a maximum height of about 60 feet; and completion of the fish traps in the center of the dam. They also call for the digging of a 1,500-foot railroad by-pass around the west abutment and the building of an operating road. The by-pass will have to be left open until all the heavy machinery for the Shasta powerhouse is delivered and until after the Southern Pacific has ceased to use the line for regular traffic. It will not, however, affect the present work at Keswick.

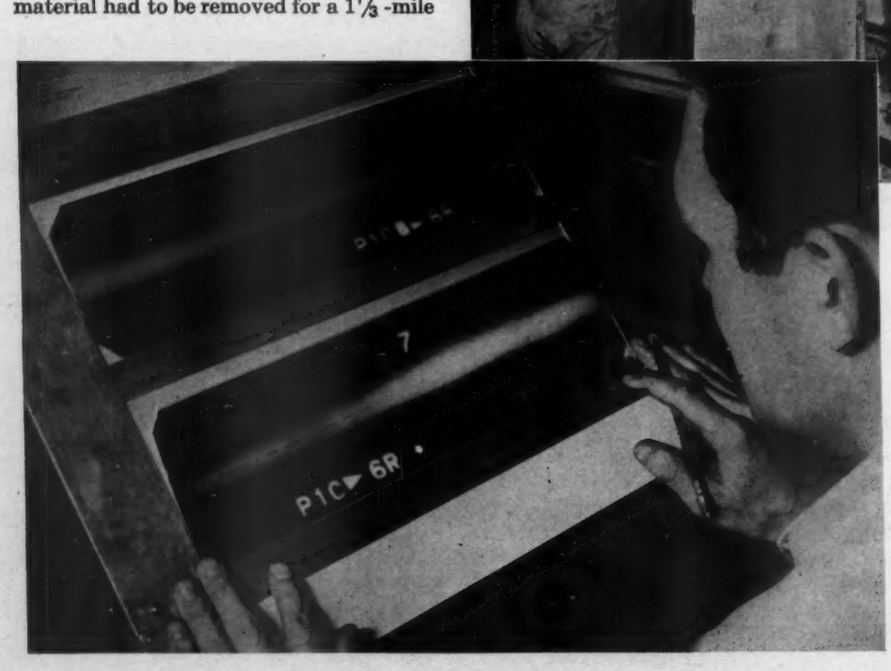
From the physical standpoint, Keswick has five sections—east and west abutments, spillway, fish trap, and power plant, the latter being a part of the dam. The excavating to be done amounts to 110,000 cubic yards of common and 286,000 cubic yards of rock, exclusive of the by-pass and right abutment above the railroad which totals 286,000 cubic yards of common and 165,000 cubic yards of rock. In addition, 40,000 cubic yards of material had to be removed for a 1⅓-mile highway from Quartz Hill Road to the Keswick site. The quantity of concrete required for the first phase of the operations will be 94,000 cubic yards—110,000 for the complete dam. The power plant will contain three main generating units, each with a capacity of 25,000 kw. As already mentioned, the manufacture of the turbines, generators, and other equipment is now under contract.

Record progress is being made on this project which, to the observer on a hillside, looks almost as big as Shasta Dam itself. The excavating is mostly finished, and concrete placing is going forward steadily. One D-4 and three D-8 Caterpillar tractors, operating 15-yard carryalls, removed the overburden in short order, and the solid rock is drilled by means of wagon drills. The usual practice is to put down 10-foot holes on 7-foot centers, some of them being sprung. About 8 pounds of Hercules 40 per cent explosive is used with Atlas caps, and an average of 18 cubic yards of rock is loosened per hole. Drill steel is conditioned in a blacksmith shop equipped with two sharpeners. The broken rock is handled by power shovels —a 2½-yard Northwest 80 and a 1¾-yard Bucyrus-Erie 43B loading into six 20-yard Mack dump trucks.

Concrete placing on the left abutment to the height specified in the first contract began on March 1. The spillway also is being poured in high and low blocks ready for the diversion of the river by cofferdams above and below the dam site. The Lidgerwood cableway employed in this work has head and tail towers of wood construction, no steel being available, and the Garbo buckets in service all came from the Mud Mountain Dam in Washington. There are ⅝-, 1-, 2-, 4-, and 6-yard buckets, so that the right one will always be at hand for the various concreting jobs, aside from the straight pouring of the blocks, that continually turn up.

The mixing plant consists of two 2-yard mixers dumping into a chute equipped with a Johnson batching system. Buckets are spotted on a landing beneath the chute and guided into position without human aid by a funnel-shaped arrangement of T-rails. Aggregates are hauled from the Columbia Construction Company's processing plant at Redding, an outside con-



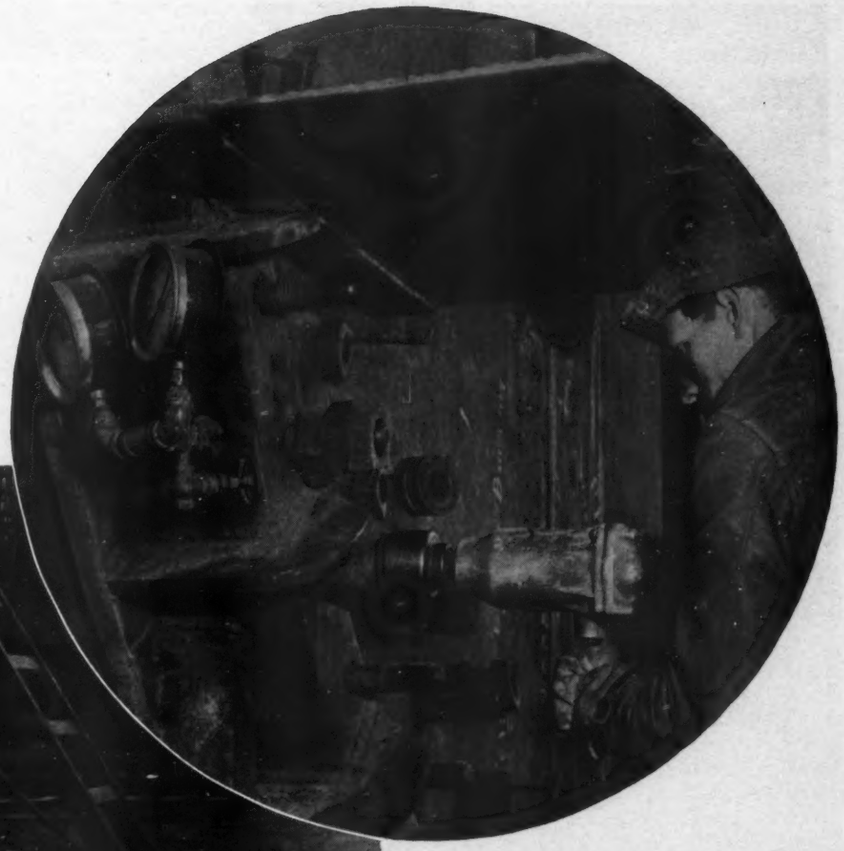


X-RAYING PENSTOCK PIPE

Standard sections of the 15-foot penstocks are made up by welding together two 10-foot rings. The joint is welded inside and out, the seams are ground down, and then X-ray photographs are taken of every foot of seam. The machine shown above will take 21,000 pictures during the fabrication of the nearly one mile of penstocks. In addition, pictures will be taken of the joints between each abutting pair of sections after they are in place in one of the penstocks. Each film is numbered by inserting lead markers in the cassette. At the left an inspector is shown comparing a film with a standard permissible-defect film in the upper frame. There is a flaw, which shows up as a fine line at the left end of the weld.

USES OF AIR TOOLS

While welds in the penstock sections are being repaired at the fabricating plant, the steel pipes are rotated on rubber-faced rollers by a compressed-air hoist (below). After they have been heated to relieve stresses, each is given a hydrostatic test at pressures ranging from 185 to 550 pounds per square inch, depending upon its location in the line. For the lower-pressure tests, heads are bolted on to each end, the nuts being run on and off with an I-R impact wrench, as shown at the right. Before being delivered for installation, all sections are cleaned with air-operated sanders (bottom).



cern doing this trucking with a fleet of ten 5- and 7-yard trucks covering a distance of 15 miles per round trip. Cement also is brought in by truck from the silos at Redding.

Compressed air for drilling and other purposes is supplied by a central plant of two 1,100-cfm. Ingersoll-Rand Type 10 stationary compressors and by one 500-cfm. portable mounted on a pick-up truck. From the compressor plant a 6-inch line is carried across the river, where it branches, one line leading to the drill-sharpening shop and the other paralleling the work to the top of the excavation. The latter has numerous drill connections of 4-inch pipe. The dam and the mixing plant are served by a 6-inch and a 4-inch line, respectively. Pressure of 105 pounds is maintained throughout the system. Cooling water for the compressor plant is obtained from a small cooling tower erected on a nearby hillside, this manner of cooling and circulating the water being more economical than pumping from the river a hundred or more feet below.

Low-heat cement is used for the dam, and a cooling system is embedded in the piers and fish trap but not in the abutments. Contraction joints are grouted, and the necessary grouting precautions are taken in the case of the foundation rock in which 30- to 75-foot holes are being drilled for low-pressure grouting. Deep grouting will come later and will be done by means of holes drilled in the one main gallery which traverses the dam. Aside from the penstocks, no conduit will be embodied in the structure. Construction of Keswick Dam represents a neat, fast-moving job. While lacking in the spectacular features of its larger fellows in the Central Valley Project, it is none the less an impressive undertaking.

Shasta Dam is being built by Pacific Constructors, Inc., with F. T. Crowe, general superintendent; W. V. Greeley, chief engineer; D. C. May, office engineer; and Frank Bryant, general foreman. Ralph Lowry is construction engineer for the U. S. Bureau of Reclamation. On the job at Keswick Dam for the Atkinson Kier Company are E. M. Jennett, resident manager, and R. J. Jenks, engineer. For the Bureau of Reclamation, C. M. Jackson is resident engineer and John J. Welch principal inspector, both under Construction Engineer Lowry at Shasta.

Revived Rico Mines Aid War Effort

Allen S. Park

All photos, Thos. J. Barbre

SURFACE EXPLORATORY WORK

After acquiring some 1,500 acres of additional ground last fall, the company started an intensive prospecting program both above and below ground. To furnish air for the surface operations, an Ingersoll-Rand 105-cfm. Mobil-Air portable compressor was purchased. It is shown here stationed at the side of a road near the Town of Rico. The timber barricade was erected to protect it from cold and drifting snow. Rico lies at an altitude of 9,000 feet, and the temperature sometimes drops to 40 below zero. Air supplied by the compressor operated Jackhamers used in sinking an exploration shaft. One of the drills is pictured above.

IN THE heyday of Colorado metal mining, the Denver & Rio Grande Railroad, under the leadership of Otto Mears, built hundreds of miles of rail line to serve the far-flung camps. This network crossed and recrossed various spurs of the Continental Divide many times, and construction was costly. Most of the right of way had to be hewn out of solid rock, and there were steep canyons to be spanned with towering wooden trestles. To save money, much of the system was built of narrow gauge. Grades were so steep and curvature so great that two or more locomotives were regularly needed to move freight trains. Measured by today's standards in flatter sections of the country, the best speed attained by the infrequent passenger trains was ludicrous. The trip from Denver to Silverton, both within the confines of one state, took several hours longer than the streamliners now require to make the 1,000-odd-mile run from Denver to Chicago. Yet, despite all these things, the road made money for a long time and undoubtedly contributed immeasurably to the development of the Colorado mining industry.

Of late years, however, the D. & R. G. has been decidedly on its uppers. The de-

MILL AND FLOTATION CELLS

At the left is a view of the mill and some of the other surface buildings. The ore train is dumping its load into the primary crusher, from which it is moved on a conveyor belt inside the inclined housing to the mill at the upper left. Below is one of the flotation cells, showing the mineral-laden air bubbles rising to the surface of the pulp. This froth is skimmed off, dewatered, and dried, yielding concentrates containing more than 90 per cent of the metal originally in the ore.

pression stifled mining and threw the road into receivership from which it has been unable to emerge. From time to time the management has petitioned for permission to abandon sections of its line, and some of these requests have been granted. But despite these amputations, the system still includes 560 miles of narrow-gauge railroad even though there is not a mile of American narrow-gauge east of the Rockies that operates regular passenger trains. Last year 179 miles of what remains of this venerable system narrowly escaped the junkman. It is the Rio Grande Southern, a subsidiary that extends northward from Durango through rugged mountain terrain. Some of the scenery *en route* is breath-taking, and so much off the sightseers' beaten path that few, even of the most widely traveled, have ever set eyes upon it. This stretch of rusting and serpentine rails was saved from the auctioneer's hammer by a woman, Mrs. Elizabeth Pellett, of Rico, who holds a seat in the Colorado State Legislature. Mrs. Pellett made a trip to Washington and convinced the authorities that the little-used section was necessary to serve mines producing vital war minerals. A subsidiary of the Reconstruction Finance Corporation bought the rolling stock for $65,000 and now leases it to the railroad. The payment enables the line to meet its current debts and will permit it to continue operating for at least a few years.

The principal mining area tapped is Rico, a community of some 1,300 persons tucked away in the mountains of Dolores County in the southwestern corner of the state and not far from Mesa Verde National Park. Colorado won its mining fame as a producer of gold, although it has been a generous contributor of some base metals. Among the latter are lead and zinc, which are obtained in various parts of the state and for the most part from mines that are in the marginal class; that is, their operating costs are such that they cannot make money when the prices of those metals are depressed. Rico, in common with most camps in the state, first produced gold and silver; but as the vein systems were followed downward the ore bodies changed to sulphides bearing principally lead, zinc, and copper.

Rico had its first flush of mining excitement more than 70 years ago; but for the past quarter-century or longer activity has been intermittent, with surges and recessions in accordance with the prices of lead and zinc. As both of these are in demand for war matériel, the camp is enjoying a modest boom. The principal producers are the Rico Argentine Mining Company, which is controlled by Salt Lake City interests, and the St. Louis Smelting & Refining Company, a subsidiary of the National Lead Company. Both concerns have operated in the area in past years, and their current activities are a resumption of those earlier efforts that were halted because of unfavorable prices for lead and zinc. This article will be confined to the Rico Argentine Mining Company, but first there will be set forth a few general facts concerning lead and zinc and their places in our present industrial program.

Lead and zinc usually occur together as the sulphides galena and sphalerite, and ordinarily are accompanied by some silver and occasionally by copper. The ore is generally concentrated by the flotation process and the concentrates are smelted. This consists in roasting them to drive off sulphur and flotation agglomerates, after which the method of treatment varies. Lead is smelted in large blast furnaces with fluxes and coke. Air is introduced to form lead oxides, and these are reduced to metallic lead which separates from the slag by gravity, is drawn off at the bottom of the furnace, and is subsequently refined to form a product 99.9 per cent pure. Zinc is either vaporized and condensed or dissolved in acid and precipitated electrically. By the former and older method the roasted concentrate (in roasting, zinc sulphide is changed to zinc oxide) is mixed with crushed coal and heated in small clay retorts. The carbon of the coal unites with the oxygen of the zinc oxide, liberating zinc in the form of vapor. This is condensed, and the metal is cast into 55-pound slabs. The newer electrolytic process is used wherever cheap electricity is available. The zinc is leached out of the roasted ore with dilute sulphuric acid and the resultant solution is filtered and purified. It is then treated in electrolytic cells where the metallic zinc is deposited on the cathodes or negative poles from which it is periodically stripped, melted, and cast into slabs.

Lead is marketed in four grades: com-

UNDERGROUND DRILLING

Most of the drilling in stopes is done with late-model stopehamers, such as the Ingersoll-Rand R-48 shown above. In narrow stopes, where room is at a premium, Jackhamers (right) are used.

mon, corroding, chemical, and antimonial. In normal times, storage batteries take nearly one-fourth of the lead used in this country. Other leading consumers are the paint, cable, building, and chemical industries. The metal has played an important part in warfare since the pre-Christian era, when warriors carried pellets of it for their slingshots and defenders of walled cities poured molten streams of it on attackers. Modern armies, navies, and air forces employ it in hundreds of ways, from bullets to protective paints. The battery room of a submarine may contain as much as 250,000 pounds of lead.

The greatest peacetime user of zinc is the farmer, who utilizes vast quantities of galvanized-steel sheets and wire. Nearly a third of the normal zinc production goes into brass. In recent years zinc die castings have attained prominence for such articles as automobile radiator grilles; and many familiar household objects such as washboards and fruit-jar covers, as well as refrigerator linings, are made of zinc sheets. Many modern paints owe their superior properties to zinc pigments, which also enter into the manufacture of linoleum, tile, glass, and other products. Zinc oxide is an important constituent of pneumatic tires and other rubber goods.

The United States leads the world in the production and consumption of both lead and zinc. The annual smelter output of each is normally more than 500,000 tons. Wars and periods of economic expansion boost the prices of both metals and stimulate production. During the Civil War lead rose to more than thirteen cents a pound, and it touched twelve cents during the first World War. In 1926 it went up to eleven cents, but in 1932 it hit the low point—2.5 cents—for the past 100 years. It soared to 7.5 cents in 1937, then slumped to less than four cents the following year. Hostilities in

SCRAPER MUCKER AND ORE TRAIN

At the right is seen a scraper-loading set-up in a stope from which it moved 18,000 tons of ore in a year. In the background at the left is an Ingersoll-Rand 15-hp., 2-drum electric hoist that furnishes the operating power. By pulling alternately on the two wire cables, which pass over pulleys at suitable points, the scraper is made to travel backward and forward, and with each forward trip it carries a load of ore to a grizzly-covered opening through which it drops to a lower level for dumping into cars. The ore is moved a distance of 75 feet and up a 15 per cent slope. The central picture shows an electric locomotive and train of loaded ore cars at the portal of the Argentine Tunnel, which is the main haulageway. For the benefit of those discerning readers who may notice that the operator does not wear a hard hat, it may be explained that he took over the train at that point—after it had emerged from underground.

Europe quickened the demand and raised the figure to an average of 4.9 cents in 1939. There has been a gradual increase since then, and the controlled price is now 6.5 cents.

As for the price of zinc, the Civil War boosted it to more than thirteen cents a pound, and during the first World War it skyrocketed to 27 cents. In the 1920's it ranged between four and eight cents, and in 1932 it sagged to just over two cents. It exceeded 7.5 cents in 1937, then settled back to a 4-5 cent range. The outbreak of war in September, 1939, led to a buying splurge, and the price jumped to 6.5 cents. That month the British Government established a price control, and in the United States zinc is now pegged at 8.25 cents.

The Tri-State District centering around Joplin, Mo., normally accounts for about 40 per cent of the nation's lead and zinc output. Only a very small quantity of lead comes from the eastern states; but New Jersey is an important zinc contributor by virtue of the New Jersey Zinc Company's property at Franklin. During the past two years domestic production of both metals has undergone considerable expansion, with the western states accounting for most of it and with Idaho, Montana, and Utah the leaders. Compared with the total for the country, or even with that for the Rocky Mountain States, the lead and zinc output of the Rico Argentine Mining Company is small; but, nevertheless, it amounted to nearly 11,000,000 pounds in 1941. This was made up of 4,818,991 pounds of lead and 6,170,073 pounds of zinc obtained from 35,720 dry tons of ore.

The Rico Argentine Mining Company was incorporated in 1911 and is one of the oldest producers in the Rico area. The current operations were started in September, 1939, the month war broke out in Europe. The renewal of activities was initiated by General Manager C. T. Van Winkle. Both lead and zinc had been selling under five cents a pound, and the district had been dormant for so long that even local residents thought resumption of mining at that time a foolish move. However, the hitherto sluggish markets for lead and zinc reacted immediately to the anticipated war demands, and prices stiffened perceptibly. Mr. Van Winkle, who reached Rico by way of Yale University and nearly 40 years of practical mining experience in Utah and Colorado, had gauged the time for reopening the old properties with accuracy.

While the underground workings were being cleaned up and made ready for production there was being built a flotation-process mill large enough to treat 135 tons of ore daily. This was an important step towards efficiency and economy, because it would obviate the necessity of shipping the bulky crude ore to smelters at Tooele, Utah, and other distant points, as had been the practice during the company's previous operations. Late in 1941 the concern added materially to its ore reserves by purchasing the combined holdings of more than 200 claims from the International and Pelleyre companies. These properties are located on Newman Hill and extend eastward over Dolores Mountain into Allyn Creek Basin and westward under the townsite of Rico, connecting with previously owned Argentine ground on the mountains to the eastward. These claims had not been mined for fifteen years, and a good deal of dead work had to be done to put them in shape for development. To outfit them properly, three air compressors and considerable other equipment had to be purchased.

The rocks in which the ore deposits occur are alternating beds of sandstone and limestone that dip at an angle of about 30° and are cut at various places by almost vertical fissures that attain great depth. The ore-bearing solutions followed those fissures, and wherever they crossed the soluble limestone strata were left behind replacement deposits of sulphide ores. The ore bodies thus conform generally to

the outlines of the limestone beds and are from 3 to 30 feet thick. There are seventeen proven lead-zinc seams under Newman Hill, and it is estimated locally that they have produced $10,000,000 worth of ore. So far, seven of the beds have been explored during the current activities. The greatest tonnage last year came from what is called the No. 4 Bed, which is reached through the Argentine Tunnel. It is from 15 to 20 feet thick and yields ore of varying grade.

Work is now being carried on through the Argentine, Blaine, and Blackhawk tunnels and the Argentine Shaft, which has been restored to gain access to ground leased from the St. Louis Smelting & Refining Company and to the lower limestone beds of the Rico Argentine Company. The exploratory operations previously planned for the latter area are now being combined with the opening of the Pelleyre group of claims. During 1940, development work totaled 3,788 linear feet, consisting of 2,018 feet of drifting, 618 feet of crosscutting, 463 feet of sinking, and 689 feet of raising. Diamond drills are used in prospecting for new ore bodies, and some holes are now being projected into porphyry areas outside the limits of the sedimentary rocks.

Mining is done by the conventional method practiced in the case of limestone-replacement ore bodies. Most drilling is done with Ingersoll-Rand Jackhamers, drifters, and stopehamers, the former serving in small stopes and drifts. Each stoping drill averages from 20 to 22 holes 4 feet deep per shift. Conventional drill steel is used, and holes are loaded with du Pont 45 per cent Gelex dynamite fired with fuses, except in wet locations where electric blasting caps are employed.

Much of the broken ore is loaded by means of four scraper units powered by Ingersoll-Rand hoists. Three of the latter —two of 4 hp. and one of 15 hp.—are air operated and the fourth is a 15-hp. electric hoist. The ore is scraped to openings through which it falls to chutes at lower levels, where it is drawn into cars having a capacity of 20 cubic feet. Beginning in February, 1941, the electric hoist worked in one stope for more than a year and moved an average of 1,500 tons of material a month. The loaded cars are hauled by electric locomotives.

At the time the current operations were started, an Ingersoll-Rand Type 10 stationary compressor was available on the property and furnished all the air required until the recent expansion program was undertaken. Last December, two I-R Type 40 air-cooled stationary compressors and a 105-cfm., oil-engine-driven I-R portable were added. As the Type 40 machines can be readily moved about and set up, and as air-cooling renders them immune to freezing, they are well adapted for service in a region where transportation is difficult and winter temperatures sometimes reach 40° below zero.

Ore from the mine is delivered to a bin, from which it is fed to a primary crusher. The crushed product travels on an 18-inch, 195-foot-long belt conveyor to a fine-ore bin at the mill. At the latter bin there is an adjustable-stroke feeder that discharges the material into a ball mill which is in a closed circuit with a classifier. In the ball mill it is ground fine enough under water to liberate the mineral particles, and the overflow from the classifier goes to the flotation section. The latter consists primarily of a selective lead-zinc circuit that meets the requirements of most of the ore. There are times, however, when the ore contains some copper-bearing mineral, and in order to treat it the mill has been designed so that it can be changed to a straight bulk-flotation system. The flow sheet of the mill was worked out beforehand in the laboratory by the Denver Equipment Company. It was thus determined what equipment would be needed, and the tests gave an accurate indication of the recoveries to be expected, the grades of concentrates to be obtained, and the operating costs. The wisdom of this preliminary work was realized when the completed mill functioned satisfactorily from the start and required no major changes after going into service.

Two banks of 8-cell Denver Sub A flotation machines are provided, and under ordinary conditions one is used for separating lead and the other for recovering zinc. When copper-bearing ore is being milled, only the lead machine is used. By the flotation process, air is introduced into a mixture of finely ground ore and water, which is known as pulp. By adding certain reagents, an affinity is created between the mineral particles and the air bubbles, and, as the latter rise, they carry the values with them to the top of the cell. There the froth is skimmed off and saved, while the waste material passes out of the bottom of the cell and is disposed of.

Reagents for the flotation of the lead are added to the ore in the ball mill and again just before it enters the lead machine. The initial flotation removes the lead particles, while the zinc minerals remain in the pulp discharge. This flows to a conditioner, where the necessary reagents are added. From the conditioner, the pulp goes to the secondary flotation machine where the zinc is separated. The concentrates from the two machines are pumped to individual thickener tanks in which the mineral particles settle and some of the excess water is removed. Further dewatering is accomplished in disk-type rotary filters from which the nearly dry concentrates pass to bins to await shipment to a smelter.

The mill is making recoveries of 90 to 95 per cent of the zinc, 80 to 85 per cent of the lead, and 95 to 97 per cent of the copper contained in the crude ore. It is handling an average of 110 tons of ore daily. The mining and milling operations give employment to 125 men. Mining is being carried on in two shifts, while milling is continuous. Because of the great demand for lead and zinc, the Government's request that the property double its output is being met.

Last December Mr. Van Winkle was made president of the Rico Argentine Mining Company. He retained his position of general manager and is personally in charge of the work at Rico. Edward Baer is mine superintendent and Ralph R. Reynolds is mill superintendent.

DIRECTING OPERATIONS

At the right is C. T. Van Winkle, president and general manager of the Rico Argentine Mining Company. With him is Edward Baer, mine superintendent. Mr. Van Winkle is a native of New Jersey, but went west shortly after being graduated from college some 40 years ago and has been engaged in mining ever since. From 1901 to 1909 he was associated with the Silver Lake Mining Company near Silverton, Colo., and subsequently was a consulting engineer in Utah.

Aluminum Goes to War

Photos by Margaret Bourke-White

The article that follows is the substance of an address that was delivered before the annual convention of the National Association of Purchasing Agents at the Waldorf-Astoria Hotel in New York on May 26 by T. D. Jolly, chief engineer and director of purchases for the Aluminum Company of America.

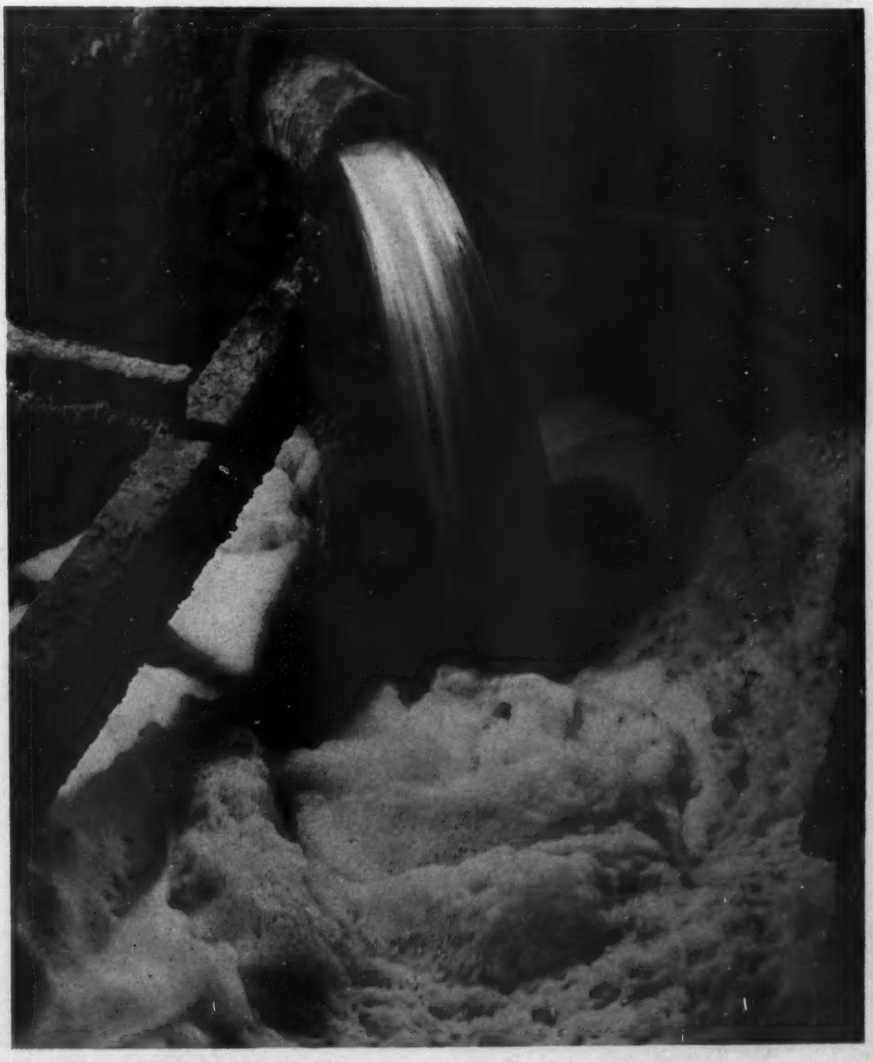
TWO months after the Munich Conference of 1938, the Aluminum Company of America set about studying its capacity to meet any demand for aluminum that might come from Britain or France should war break out. A 6-man committee, representing various departments within the company, was appointed and made frequent reports to the management as conditions changed throughout 1939. Based on these reports, and disregarding both the large stock of metal on hand and the apparent small requirements of the armed forces of this country, a program of expansion was inaugurated which, with the additions since made, calls for a capital expenditure on the part of the company of about $250,000,000. This expansion is now substantially completed.

On February 12, 1940, the Russo-German economic treaty was signed, and on March 8 construction was started on a plant to produce 30,000,000 pounds of aluminum ingot per year. A month later, Germany invaded Denmark, and on April 16 it was agreed to increase the capacity to 60,000,000 pounds. On September 1 our National Guard units mobilized; two days later the Navy Department announced the transfer of 50 United States over-age destroyers to Britain in exchange for air bases; and on September 14 the compulsory-draft bill passed. With the United States embarked on a defense program, a further increase was decided upon—this time to 160,000,000 pounds. Other aluminum plants were being expanded to the limit of the available power, and work was begun on two hydroelectric projects, while mining operations, ore refining, and fabricating facilities kept pace with these activities. But as both funds and credit of any privately owned industry are limited, it was obvious by midsummer of 1941 that no one concern could finance the full aluminum requirements.

On August 19, 1941, the Aluminum Company of America signed a contract with the Defense Plant Corporation to design and build at cost, without fee or profit, one ore-refining plant and three metal-producing works. By a supplemental agreement of December 12 it undertook to construct two additional metal-producing works. Months before any contract was signed, the company became convinced that these Government plants would have to be built and that it would have to build some of them. Accordingly, it obligated itself for something in excess of $16,000,000 worth of equipment to be used in their construction. Thus many weeks of valuable time were saved and two of the aluminum plants are now in operation. The three others will come along in the near future.

Since then the company has started on another program for the Defense Plant Corporation. Censorship rules do not permit disclosure of the type, capacity, or locations of the new works, but it can be said that fifteen plants are being built and that they are situated in eight states. Taking into account its own program, the company now has underway 35 major projects, bringing the total floor space put under roof since January 1, 1940, to 335 acres. By May 2 of this year it had placed for the Defense Plant Corporation 108 subcontracts, of which only eight were negotiated, and obtained 400 bids for the 100 competitively awarded contracts. There are still others that have not yet been closed. By that time a force of 7,920 men was engaged directly on construction work and 17,500 purchase orders had been placed.

Summing up: By the end of 1943, the annual output of aluminum in the United States will be approximately 2,100,000,000 pounds—6½ times that of 1939. Several of the new plants will each produce more aluminum than the entire nation made at its World War I peak—and still there will not be a pound available for civilian use. How much is 2,100,000,000 pounds of aluminum? It is sufficient to rebuild every railroad passenger car in the United States three times a year. Or it could be utilized, were we not at war, to put a set of 30 cooking utensils in every one of America's 34,000,000 homes, with enough metal left over to manufacture 5,000,000 miles of transmission cable of the type used in



PUMPING SODIUM ALUMINATE LIQUOR INTO A PRECIPITATION TANK

1936-1940 for the electrification of rural America.

In producing aluminum we start with a mineral called bauxite, which contains about 55 per cent of hydrated aluminum oxide and such impurities as oxides of iron, silicon, titanium, etc. The bauxite is ground to a fine powder and digested in a hot caustic solution under pressure. The aluminum hydrate is dissolved in the liquor and passes with it through a filter press, leaving the remainder of the bauxite, commonly called red mud, to go to waste. The liquor is then cooled and flows into large tanks, where the aluminum hydrate is precipitated. This is washed to remove soda, thickened, calcined, and sent to reduction plants as alumina. The ore-refining process requires large quantities of water, steam, soda ash, and lime.

The alumina, or aluminum oxide, is reduced to metallic aluminum in long rows of electrolytic cells each of which consists of a steel shell lined with carbon, which serves as the cathode. Electricity is led into each cell through carbon anodes suspended from bus bars above the cells. In the operation of a cell, the aluminum oxide, dissolved in a bath of molten cryolite, is decomposed by the passage of the electric current. Cryolite is found in commercial quantities only in Greenland, but the United States has facilities for making a material that is the chemical equivalent of natural cryolite and that is suitable for the production of aluminum. At the present time additional electrolyte plants are being built to make us entirely independent of Greenland cryolite.

The bath material is first introduced into the cell, and when it has been melted by the electric current the alumina is added. Low-voltage, direct current is used, and separates the aluminum oxide into aluminum and oxygen. The latter, liberated during the reaction, combines with the carbon anode to form gas which escapes, while the aluminum is deposited on the bottom of the cell where it remains as a molten layer until tapped off. When the alumina in the bath is exhausted, more is put in, and the cycle is repeated.

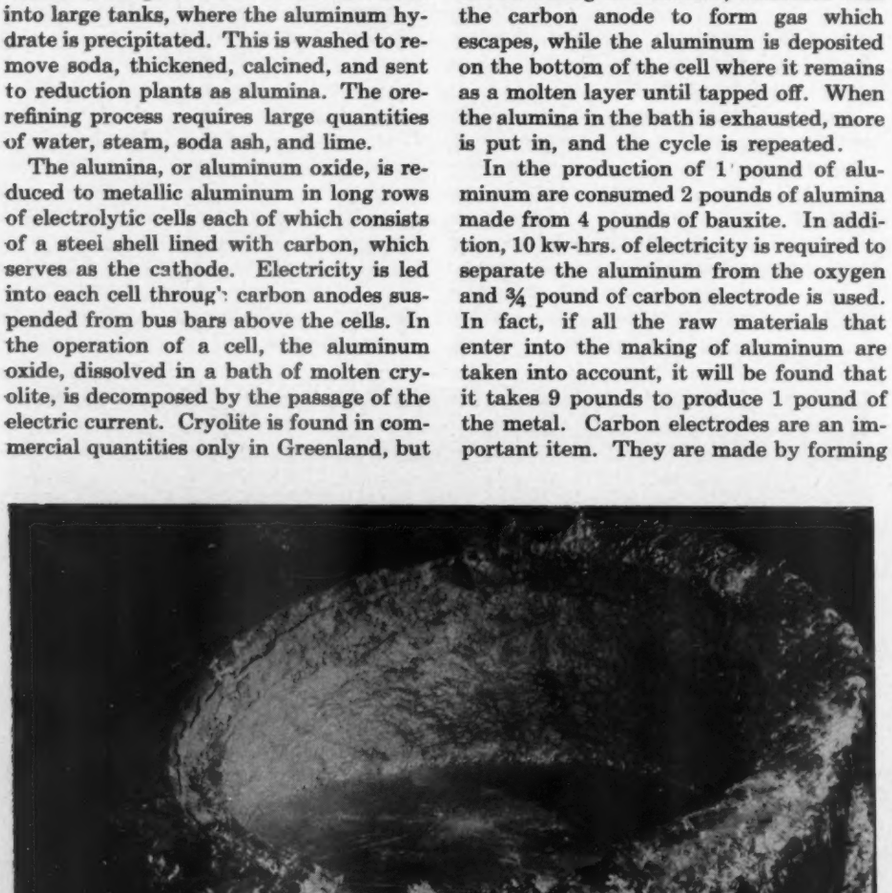
In the production of 1 pound of aluminum are consumed 2 pounds of alumina made from 4 pounds of bauxite. In addition, 10 kw-hrs. of electricity is required to separate the aluminum from the oxygen and ¾ pound of carbon electrode is used. In fact, if all the raw materials that enter into the making of aluminum are taken into account, it will be found that it takes 9 pounds to produce 1 pound of the metal. Carbon electrodes are an important item. They are made by forming a hot mixture of coal-tar pitch and calcined petroleum coke in molds under hydraulic pressure. After baking and cleaning, the former to remove the volatiles from the binding material, they are ready for use. Large quantities are needed, and it is therefore necessary to provide facilities for their manufacture to keep the aluminum plants supplied.

The major item is, of course, electricity. To produce the 2,100,000,000 pounds of aluminum, the industry will require annually more current than was consumed in 1940 in 27 of the 48 states—yes, more in one day than a city of 60,000 homes needs in one year. This big block of energy comes from three sources: company-owned hydroelectric stations, Government water-power plants, and steam and hydroelectric stations operated by privately owned public utilities. For every dollar invested in plant and equipment at the Aluminum Company's large Tennessee works, for example, there is another dollar invested in the mountains in water-power plants. In addition, current is supplied by TVA stations as well.

It is interesting to look back and see how conditions and purchasing problems have changed in the comparatively short time this work of expansion has been underway. It started even before there was any thought of serious shortages of materials. Then came the defense program and voluntary priorities on some products, and, as defense plans developed, so did mandatory priorities. And it might be added, that the aluminum industry appreciates their meaning because it was the first to be placed on priorities. These were followed by allocations, restrictions, and prohibitions in the use of materials, as well as by frozen price levels.

In the case of the Aluminum Company's expansion program, it was cheaper and quicker to enlarge existing plants and, where possible, to construct new works near old ones in order to take advantage of the supervision and experience of the available personnel in creating new operating organizations. However, as it is building today an industry seven times the size of its peacetime industry, the personnel is spread pretty thin. The first Defense Plant Corporation sites were selected four to six months before Pearl Harbor and were recommended by the Office of Production Management after a study of markets, source of raw materials, power, labor, accessibility, foundation conditions, and surroundings.

Because of the enormous quantity of power required and the shortage of materials it was necessary to locate the new works where the least possible amount of copper would be used for transmission lines. This reverses the old theory of placing aluminum plants in sparsely settled areas where low-cost power is plentiful because there are few if any customers for it. Under present conditions there is far more power available in our large metropolitan



POURING ALUMINUM PIGS

districts than elsewhere. Since it has been officially announced, it is all right to say that the country's largest aluminum-producing plant is now building at a point about ten minutes by automobile from the heart of one of our big cities. A unique feature of it will be its pure-silver bus bars and silver-wound transformers. The Conservation Branch of the War Production Board solved the copper problem involved by arranging this substitution.

The Government-owned plants need about 36,000 tons of bus bars. If we add the requirements for light and power wiring, motors, and miscellaneous uses, it is entirely too much of a drain on our copper reserves in these days of heavy military demand. In the case of the new program, the U. S. Treasury will lend silver for the purpose from the vaults at West Point. It will be fabricated by the copper companies and shipped ready to install. Present plans call for approximately 13,000 tons of the metal for bus bars. At the end of the emergency it is to be returned to the Treasury.

Before the Aluminum Company of America started building for the Government, it was decided that it would be necessary to standardize structures and equipment as much as practicable in order to complete construction and to begin manufacture at the earliest possible date. This has paid big dividends on the work and has also benefited many people who furnished machinery. For example, since January 1, 1940, one crane manufacturer has received orders for 175 cranes, all of the same span and capacity. The only change in specifications concerned a few motors. The builder was able to set up a production line, thus stepping up efficiency by more than 50 per cent, as compared with normal practice when the shop is filled with miscellaneous cranes. Foundries turning out castings, as well as all other suppliers, were likewise able to speed up because of duplication.

As many as 72 buildings are based on the same shop drawings, and there are numerous other cases of duplication. The most interesting one is that concerning a powerhouse where natural gas is being provided at very low cost. Temporary power was to be supplied until the steam plant was in operation, but as no amount of standardization could assure quick delivery of 35,000-kw. steam-driven turbo-generators, and as there was need of a quick source of power, other arrangements had to be made. Seventy-eight gas engines are being installed, 60 driving a 750-kw. generator each and eighteen equipped with 2,250-kw. generators, all direct-current machines transmitting power direct to the production line. The conventional procedure is to convert alternating into direct current by means of mercury-arc rectifiers. By eliminating the latter the gas-engine power will compare favorably in cost with that from other sources, and with low-priced gas the plant will, it is believed, be a very economical one despite the large number of units required.

ROLLING ALUMINUM SHEETS

Every operation on each construction job is scheduled before the work is started. This necessitates careful planning so that each piece of equipment will arrive at the proper time for installation. Aluminum reduction plants cannot run without alumina, carbon electrodes, and electrolyte, and plants of commensurate size are being built to produce all three of these. To correlate the efforts of the purchasing, engineering, and construction departments to keep jobs on schedule there has been set up in the general office a coördinating department where copies are kept of all schedules, purchase orders, and weekly building reports. Further, in each sales office there has been selected a veteran salesman to act as regional coördinator. He has available, on a first-demand-duty basis, the services of each of the other salesmen in his office. This gives speedy person-to-person contact with suppliers. The coördinator's department does not assume the prerogatives and responsibilities of the purchasing department, it merely acts for the buyer and relieves him of the task of following up his orders. It also works with the general construction superintendent and sees to it that materials and equipment are on hand when needed. It is not its job to worry suppliers into making shipments, but, instead, to help them obtain materials from their suppliers, and so on. It is purely a coöperative organization, and no small part of its dealings are with the priority division. At first all priority certificates were handled through one man, as it was more or less a spare-time job, but as the number of forms and reports increased it was necessary to create a priority division which now numbers sixteen.

Aside from operating expenditures, the Aluminum Company of America will have spent for construction from January 1, 1940, to the middle of 1943, just about $600,000,000. It has not yet fallen seriously behind schedule, and in some cases has been ahead. No organization of its size could possibly handle such monumental work without the coöperation of everyone connected with it—everyone from the blueprint boy on up through the engineering, purchasing, construction, operating, coördinating, and priority departments, not excepting some suppliers.

Getting the Most Out of Your Air Tools

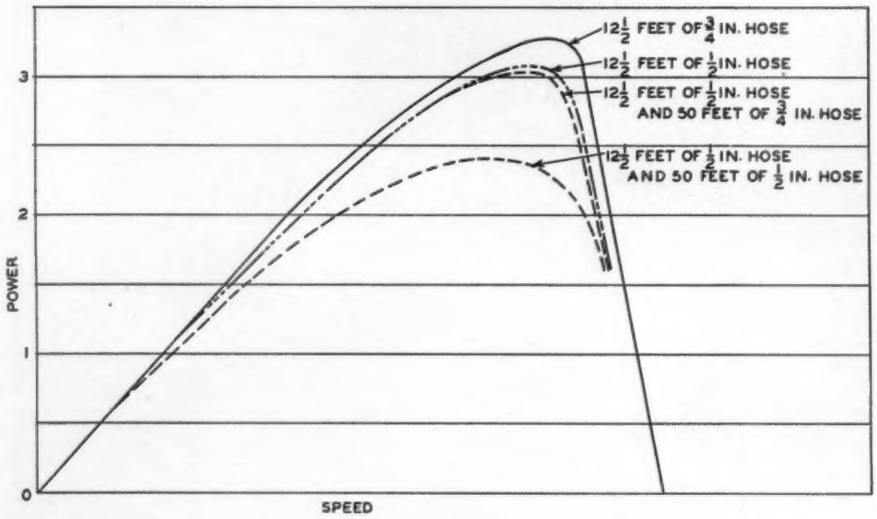

12½ FEET OF ¾ IN. HOSE
12½ FEET OF ½ IN. HOSE
12½ FEET OF ½ IN. HOSE AND 50 FEET OF ¾ IN. HOSE
12½ FEET OF ½ IN. HOSE AND 50 FEET OF ½ IN. HOSE
POWER
SPEED
0
1
2
3

FIGURE 1

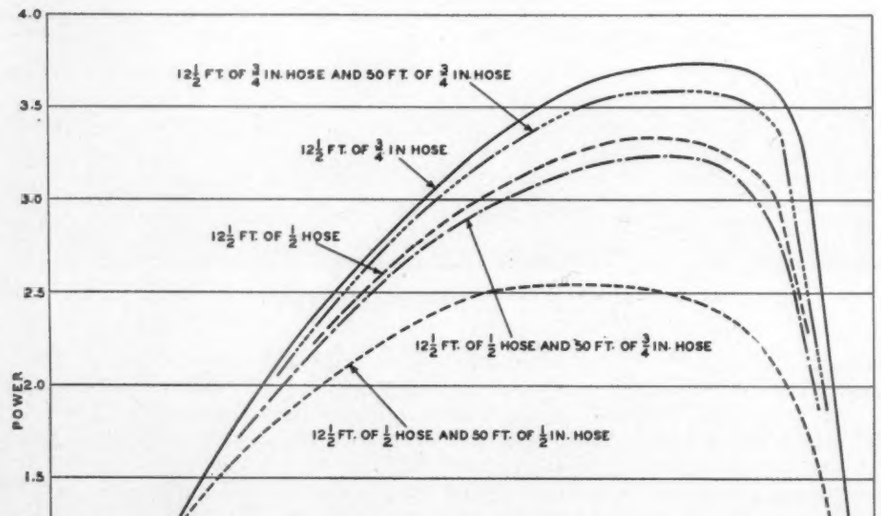


FIGURE 2

COMPARISON OF AIR-PASSAGE AREAS OF TYPICAL HOSE NIPPLES

Tools	Nipple Size	Hole Diameter	Air Passage Area
Hammers.....	½-in. hose to ¼-in. pipe	17/64 in.	0.055 sq. in.
Rotary*.....	½-in. hose to ¼-in. pipe	11/32 in.	0.093 sq. in.
Rotary*.....	½-in. hose to ⅜-in. pipe	13/32 in.	0.130 sq. in.

*Drills, grinders, impact wrenches, etc.

THE events of the past few months have crystallized America's determination to go "all out" in her plans to win the war. The responsibility rests upon all of us—as individuals, as Government agencies, as production forces. It goes without saying that we should do everything possible to keep the performance of our mechanized tools at peak level. When this peak is not reached, efficiency is lowered.

One of the most important and widely used types of equipment is the air-operated tool—the hand-held drill, grinder, riveter, impact wrench, etc. The aircraft and shipbuilding industries—vital to our war program—find them indispensable in their intensified work. Modern pneumatic tools are the lightest, most compact, and most powerful machines that can be placed in an operator's hands. They embody high flexibility of control, and their power, combined with light weight, makes possible longer and more productive working hours with less fatigue on the part of the user. But, to assure sustained maximum efficiency, they should be properly handled and carefully maintained.

Clean, dry air at suitable pressure is a prerequisite for smooth operation and long life. For best results the average tool requires about 90 pounds pressure at the inlet. Few users realize to what extent pressure drops as the rate of air flow increases. They are careful about maintaining pressure at the compressor, and frequently check the hose inlet, but rarely do they devote sufficient thought to the pressure at the tool itself. The error of this is evident. The pressure at the tool determines the power the tool will develop.

If certain fundamentals are neglected, if simple precautions are not taken, substantial power losses will occur between compressor and tools. A large share of these losses is apt to result from the use of improper hose and fittings, but they can be virtually eliminated at small expense by changing hose hook-ups. Hose, couplings, nipples, and menders that are not suitable restrict the air flow and reduce the working pressure at the tool. To emphasize this, the effect of various hose arrangements on the performance of a heavy-duty grinder is graphically illustrated in Figure 1. Obviously, for best performance, a ¾-inch hose should be utilized with a tool of this size—one consuming 55 to 65 cfm. at 90 pounds pressure. The curves also indicate that a 12½-foot whip of ½-inch hose may be employed in conjunction with a longer ¾-inch hose without serious loss of power. On many jobs long lengths of ½-inch hose are commonly in service, but the loss of power (25 per cent and more) is a high price to pay for any minor advantages gained by the use of the smaller hose. From the operator's standpoint, flexibility has in the past constituted an advantage in the case of the latter, but with the introduction of highly flexible ½- and ¾-inch-diameter hose, that ad-

vantage can no longer be claimed for it.

Similar performance curves of a Multi-Vane drill with various hose arrangements are shown in Figure 2. Corresponding curves indicating the pressure at the throttle have been plotted in Figure 3 and illustrate not only the actual drop from the 100-pound pressure maintained in the line but to what extent rate of air flow affects pressure drop. While a 12½-foot length of ½-inch hose may be used with a tool consuming 75 to 85 cfm., there will be a power loss of about 10 per cent, compared with a similar length of ¾-inch hose. Loss of pressure always means less work done by the tool.

Included in this article is a table for determining the hose arrangement best suited for any air-operated tool. In making a selection, the hook-up should be based on the air consumption of the tool when operating under full load—maximum horsepower. The figure will be found in the tabulation under the heading *Air Flow Cubic Feet Per Minute*, and in line with it are various pressure drops. By choosing the acceptable drop for the tool in question it is possible to determine quickly the length and diameter of hose required.

In many layouts, much of the pressure drop is attributable to hose couplings, nipples, and menders. As the hole through these fittings is of necessity smaller than that in the hose, it is important to use fittings having the largest practicable inside diameter. Certain shops commonly standardize on ½-inch hose and equip all hose whips with ½-inch hose to ¼-inch pipe nipples. Tools having air-inlet pipe taps larger than ¼ inch must then be provided with reducing bushings if they are to be used with the existing hook-up. The error of this practice is evident.

An accompanying table gives a comparison of the air-passage areas of typical hose nipples for hammers, drills, grinders, etc. Examination of it will reveal that chipping hammers and similar percussion tools use less air than do rotary tools. For that reason a ½-inch hose to ¼-inch pipe nipple designed for chipping hammers has a smaller hole than that supplied for drills, grinders, etc. It will also be observed that the substitution of the ½-inch hose to ⅜-inch pipe nipple for the respective ½-inch hose to ¼-inch nipple will, in the case of hammers, give an air passage with more than twice the area and in the case of rotary-driven tools approximately 40 per cent greater. This emphasizes one more phase of our original contention; namely, that improper hose and nipples reduce air pressure at the tool and lower the productive capacity.

Air mains and lines should be large enough to avoid excessive pressure loss under conditions of maximum flow. In air lines, as in aftercoolers, water is precipitated as the air cools. For this reason pipe lines should be provided with means for drawing off or trapping the water before it reaches the hose outlets. It is advisable to pitch the mains in the direction of flow so that both flow and gravity will carry it to traps or water legs placed at frequent intervals. These should be emptied regularly and should never be allowed to become full—inoperative. Automatic traps make it possible to dispense with

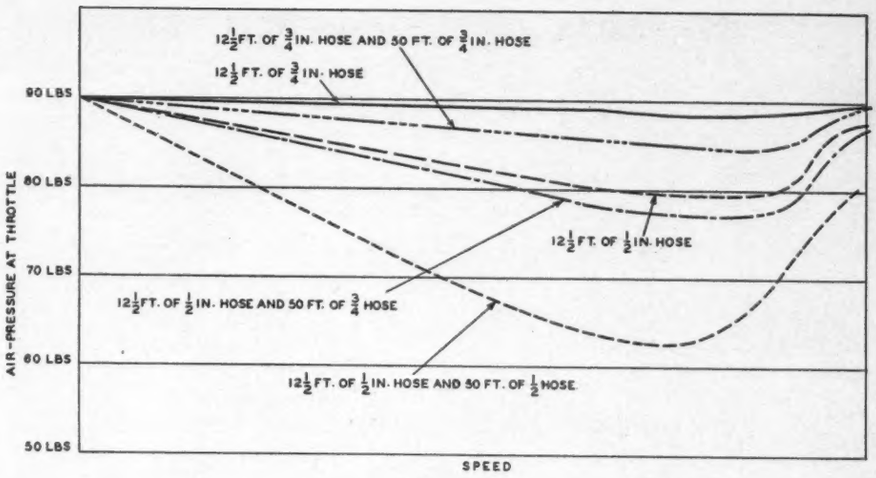
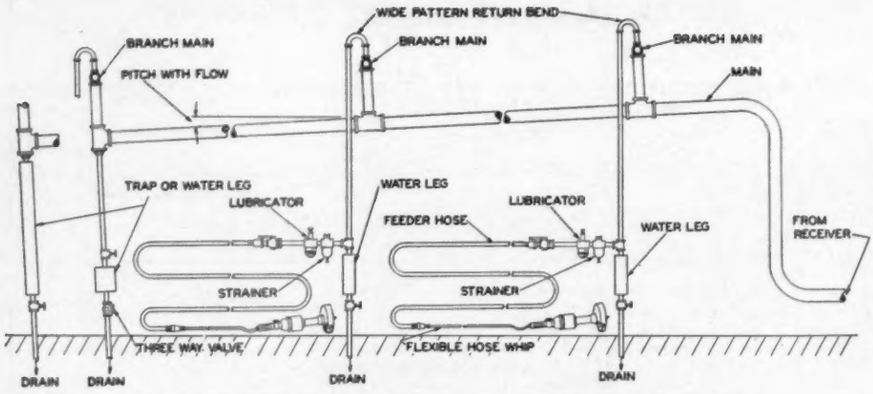

12½ FT. OF ¾ IN. HOSE AND 50 FT. OF ¾ IN. HOSE
12½ FT. OF ¾ IN. HOSE
90 LBS
80 LBS
70 LBS
60 LBS
50 LBS
AIR-PRESSURE AT THROTTLE
12½ FT. OF ½ IN. HOSE
12½ FT. OF ½ IN. HOSE AND 50 FT. OF ¾ HOSE
12½ FT. OF ½ IN. HOSE AND 50 FT. OF ½ HOSE
SPEED

FIGURE 3

Air Flow Cubic Feet Per Minute	10' of ¼" Hose	8' of ⅜" Hose	10' of ⅜" Hose	12½' of ⅜" Hose	25' of ½" Hose	50' of ½" Hose	12½' of ¾" Hose	25' of ¾" Hose	50' of ¾" Hose	50' of ½" Hose + 10' of ¼" Hose	50' of ½" Hose + 10' of ⅜" Hose	50' of ½" Hose + 8' of ⅜" Hose	50' of ½" Hose + 12½' of ½" Hose	50' of ¾" Hose + 25' of ½" Hose	50' of ¾" Hose + 12½' of ¾" Hose
	Pressure Drop—Pounds per Sq. In.—Based on 100 Pounds per Sq. In. Line Pressure														
10 to 11	5.0	.9								5.3	.7	1.4			
11 to 12	5.9	1.0								6.2	.8	1.6			
12 to 13	6.8	1.2	.4							7.2	.9	1.9			
13 to 14	8.0	1.4	.5							8.4	1.1	2.2			
14 to 15	9.3	1.6	.6							9.8	1.3	2.5			
15 to 16	11.0	1.9	.7							11.6	1.5	2.9			
16 to 18	14.0	2.4	.8							15.0	1.9	3.5	1.7		
18 to 20	19.6	3.0	1.0							21.4	2.4	4.5	2.0		
20 to 25		4.3	1.4	.7	1.0	1.3					3.5	6.4	2.6	1.3	
25 to 30		6.6	2.1	1.0	1.5	2.3					5.2	9.8	3.8	1.9	
30 to 35		9.5	3.1	1.3	2.1	3.6					7.3	13.7	5.3	2.6	
35 to 40		12.8	4.2	1.7	2.8	5.2					9.6	18.4	7.1	3.5	
40 to 50		19.3	6.3	2.4	4.1	8.0					14.0		10.4	5.2	1.8
50 to 60			9.6	3.7	6.3	12.2					21.8		16.0	7.8	2.3
60 to 70			13.5	5.3	9.0	17.4	.9	1.4	1.9				22.8	11.1	3.0
70 to 80			18.7	7.1	12.4		1.1	1.7	2.5					15.0	3.7
80 to 90			25.0	9.0	16.1		1.4	2.2	3.2					19.8	4.6
90 to 100				11.1			1.7	2.7	4.0						5.8
100 to 120							2.3	3.5	5.6						7.9
120 to 140							3.2	4.8	8.0						11.2
140 to 160							4.3	6.6	11.0						15.5
160 to 180							5.6	8.7	15.2						20.4
180 to 200							7.2	11.0							
200 to 220							9.0								

RECOMMENDED HOSE ARRANGEMENTS FOR AIR-OPERATED TOOLS

Under the heading "Air Flow Cubic Feet Per Minute," find the rate of flow comparable to the air consumption, at maximum horsepower, of the tool being used. Follow the line and select the acceptable pressure drop for that tool to determine a suitable hose arrangement. Readings should be taken above the heavy line because the hose arrangements indicated by those below will lead to a relatively high pressure drop, with a proportionate reduction in power for the tool. All computations are based on the use of Ingersoll-Rand Type A couplings.



RECOMMENDED LAYOUT FOR AIR-PIPING SYSTEM

manual draining. However, when arranged to discharge into sewers they are wasteful of air unless kept in good working order. Provision should therefore be made for quick and positive inspection, for which purpose the drains are usually equipped with 3-way, stop, or waste cocks.

Down-pipes or hose should never take off directly from the bottom of air mains. Connections should be made at the top of the main, and a long-radius return bend should be used. Adherence to this rule will help to prevent water from reaching the tools. Leaders, valves, and hose connections should be large enough to permit passage of the maximum amount of air for efficient operation of the tool or tools on the line. This is particularly important if the system is provided with manifolds each serving several hose lines.

Though leaks may be small and of little consequence individually, their cumulative effect is loss of pressure and a proportionate reduction in power. Before the war, many plants using compressed air made a practice of testing for leaks at regular intervals. This was usually done on a Saturday afternoon or Sunday. Today, with most industries working full time, week-end shutdowns are not always possible. As a result, maintenance of the compressed-air systems is more vital than ever, and air mains, hose, coupling, etc., should receive daily attention. If this is done, leakage can be kept at a minimum.

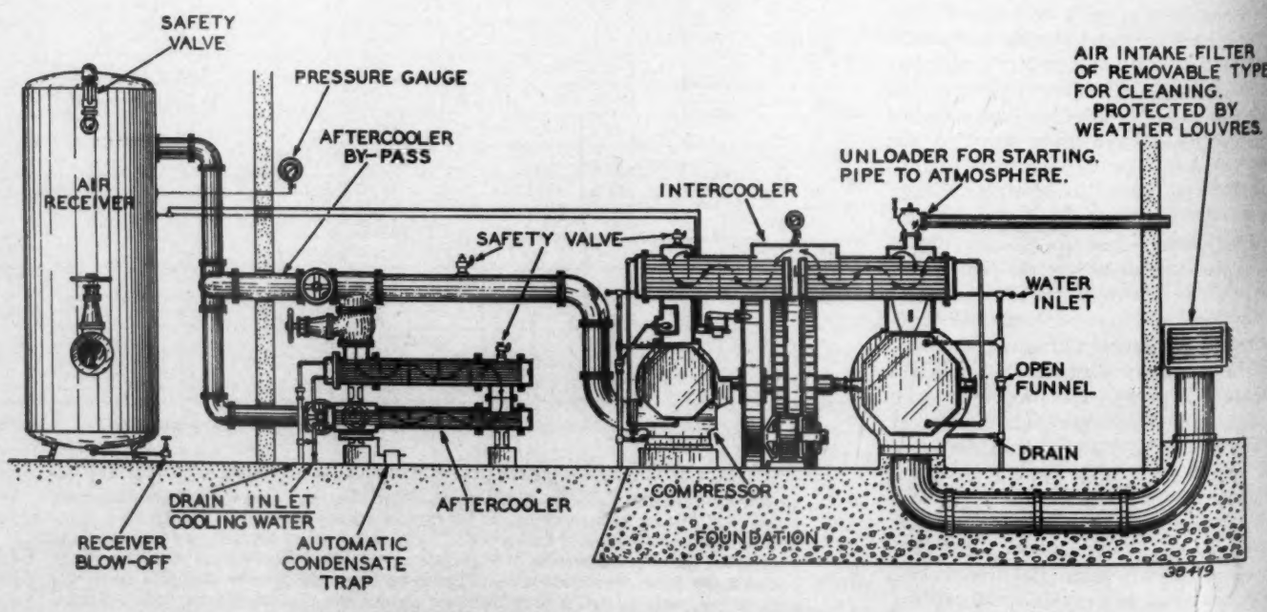
Frequently, when more air-operated tools are added to a system no thought is given to the increased demand on the compressors themselves. If the capacity of the existing plant is too small to handle it, then one or more units should be installed. A constant-speed compressor can deliver only a given volume of air per minute at a prescribed pressure, and if this volume is less than the combined requirements of the tools, the line pressure necessarily drops.

The compressor intake should be placed where it will obtain the coolest, driest, and cleanest air available, and, where practicable, the air should be taken from outdoors on the north side of the building. Ducts should be of ample size and as short and direct as possible. Steam pipes, escaping steam, and wet or dusty locations should be avoided. Putting the intake near the roof, floor, or on the ground is not recommended, and adequate screening and intake filters should be provided.

The percentage of moisture carried by compressed air varies with the temperature and is a matter that requires careful attention because the humidity in most parts of the world is relatively high. As the temperature drops after compression, water is precipitated. To eliminate as much of it as possible, compressors should be equipped with intercoolers, aftercoolers, and receivers of ample size. These should be kept drained and in good working order.

For installations where the piping system does not supply clean, dry air, the use of separators and filters at hose-connection points is recommended. A good separator, kept properly drained, will remove nearly all the entrained water; but a poor one is practically worthless. Most separators do not have adequate water-storage capacity and, unless provided with an auxiliary receiver or automatic trap, soon cease to function. Air filters remove pipe scale, rust, and any other foreign matter that might impair the tool. Many tools have air strainers, and these must be kept clean and free from obstructions to prevent air restriction. There should be a strainer or filter at each hose outlet, particularly where pipe lines are old or are used intermittently.

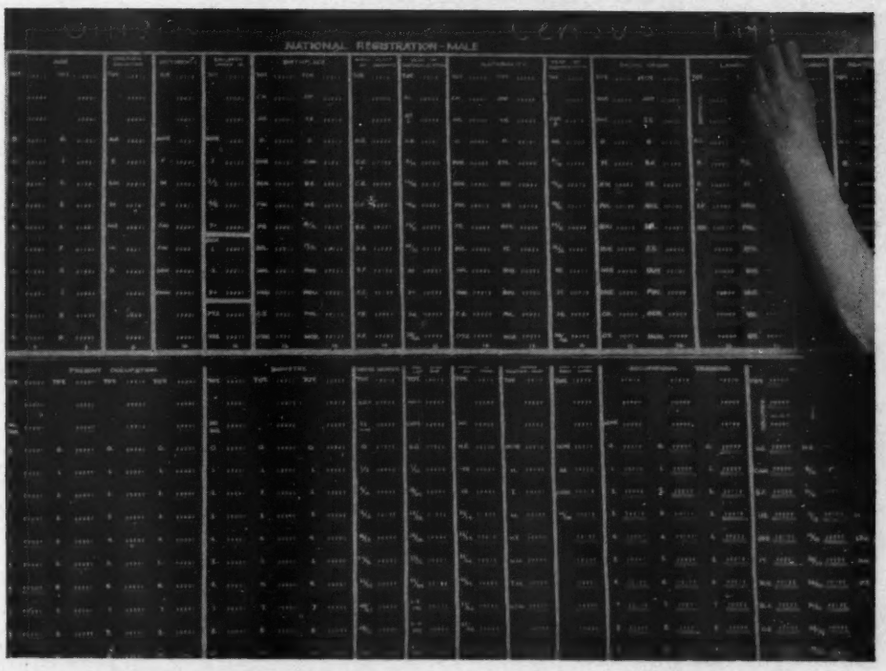
Because of their weight and the space required, built-in lubricators are not always included in pneumatic tools. Where that is the case, air-line lubricators should always be provided, and are, in fact, advocated for pneumatic tools. In addition, gear chambers, hammer cases, bearings, etc., should receive proper quantities of recommended greases.



RECOMMENDED LAYOUT FOR AIR-COMPRESSOR PLANT

Mechanical "Brain" Aids Canadian Census Takers

Robert N. Bryan



LIGHTNING CALCULATOR

At the left is shown the tabulator head and the maze of tubes that carry compressed air to the 546 plungers that actuate the counting mechanism. Fernand Belisle, inventor of the machine, is at the left, and with him is A.E. Thornton, superintendent of mechanical tabulation. The two men jointly hold the patent rights on the machine. There are six of these calculators in the Dominion Bureau of Statistics at Ottawa. Largely because of the time they save in tabulating the voluminous data, Canada's census costs only 3½ cents per capita per year. The upper picture shows the counter face of the machine, a 48x36-inch panel on which the figures appear. A black curtain, with identifying symbols alongside apertures exposing the figures, is hung over the panel, of which a photostat is then made to serve as a permanent record. The curtain varies in accordance with the tabulation.

TO THE uninitiated, the taking of a census is a relatively simple but tedious matter during the course of which an inquisitive investigator asks personal questions about John and Jane Doe. After his visit, Mr. Average Citizen usually forgets about the pad-and-pencil man until apprised, months later, that the home-town population is on the uptrend. Following this period of awareness, he is prone to forget the census again for another ten years.

It is perhaps no exaggeration to say that this attitude is common both here and in Canada. Like Americans, our northern friends probably do not realize the immense amount of work involved in a census tabulation, nor do they appreciate its tremendous value. Canada began her most recent census-taking in 1939, and it is estimated that the tabulating and analyzing of the results will not be finished until 1944. The fact that it will require five years to complete the job gives some idea of its magnitude. To quote the *Winnipeg Free Press*, the Canadian "is one of the best enumerated citizens in any country in the world."

As in the United States, census-taking north of the border is more than a matter of asking questions and writing down answers. Relatively speaking, this question-and-answer routine is the least part of the work. The most important phase is the disposition of the material by the Dominion Bureau of Statistics. Let us say, for example, that the Canadian Parliament decides to establish a plan for national health insurance. One of its first official acts will be to consult the statisticians, for most if not all the pertinent statistics will be gleaned from the facts and figures gathered and tabulated by the census bureau.

In Canada, the three outstanding census personalities are Dr. R. H. Coats, dominion statistician; S. A. Cudmore, assistant dominion statistician; and A. J.

Pelletier, chief of the census branch. For these men, the census and census statistics constitute a career, a life work. After the data have been recorded by investigators, checked by local census commissioners, and checked again by the bureau in Ottawa, the job of coördinating the information presents itself. The first step is the punching of a code card for each of the millions of people listed. Each of the many holes with which it is perforated has a meaning of its own that is printed on the card in the form of a code number or abbreviation. Hundreds of facts can thus be recorded on a single card measuring only 7⅜x3¼ inches, and a competent operator can punch 1,000 a day.

After verification by an electric device to insure accuracy, the cards are sent to a complex sorter-tabulator, a mechanical marvel invented by Fernand Belisle, a French-Canadian associated with the Dominion Bureau of Statistics. As an example of ingenuity and all-around efficiency the machine probably has few peers. Aptly called the automatic compressed-air tabulative brain, it works with a degree of speed and accuracy that could not be equaled by the most skillful human. The accompanying illustrations show certain details of the machine, and we would suggest that the reader refer to them for a better understanding of the following description of the more important steps in the tabulation of the assembled data.

First, the punched cards are sorted according to geographical areas. Then they are stacked in the hopper of Mr. Belisle's tabulator into which each is fed automatically from the bottom of the pack. As it reaches the head of the machine, it is momentarily stopped directly under the head or air chamber, which has an outlet for every hole punched in the card. Beneath the latter are more holes, which correspond to those in the air chamber and from which macaronilike tubes lead to hundreds of air plungers that are mounted in front of special pawls. These are actuated by the plungers and operate the 546 individual Veeder counters that do the actual work of tabulating.

The force which motivates this manifold plunger-and-pawl system is compressed air at a pressure of 15 pounds per square inch. In other words, wherever there is a hole in the card, there the air is released and flows through, for, as already mentioned, there is an opening in the air chamber with an associate tube for every possible hole in the card. The pressure of the air rushing through this channel actuates the proper Veeder counting mechanism. The entire action is accomplished by holding the head tight against the card during its momentary stop so that air can be shot through all the holes and thus to their respective counters.

The Veeder counters are arranged in 42 rows of thirteen each. Of these, twelve represent individual items and the thirteenth or upper counter represents the total or summary of the separate items. It operates in unison with any counter in its particular column such, for example, as "Birthplace," "All Age Groups," "Immigration Dates," "Religion," etc. The tabulation, therefore, takes care of all the information on the card in one operation. Suppose, for instance, that the statisticians desire to tabulate a city or town by sex. The male or female cards are placed in the hopper of the machine. They are then fed through at the rate of 250 a minute, and all the "punched" facts are recorded by the Veeder counters.

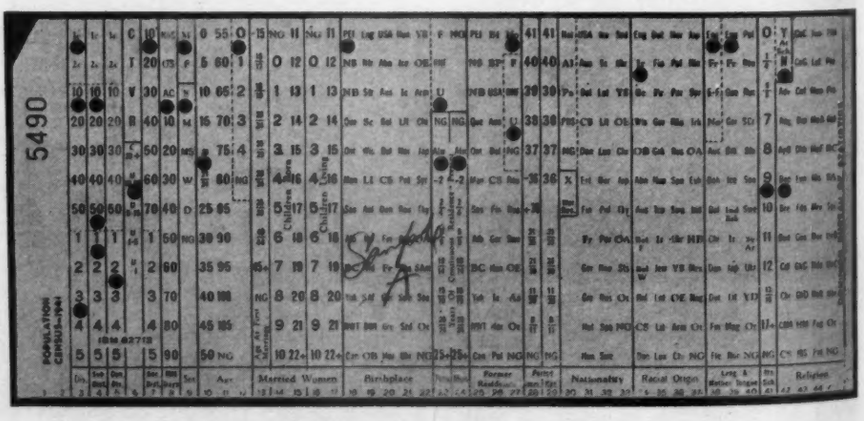
The counter face of the machine is a 48x36-inch panel covered by a black rubber curtain with 546 apertures or windows which expose the figures recorded on the panel by the counters. Alongside each aperture, marked in white on the black curtain, is a symbol which explains the meaning of the figures. The latter also are white on a black base.

Using a device with a prism lens, the statistician makes a photostat of the counter face, reducing its dimensions to 24x18 inches. The finished print constitutes a permanent record with every fact clearly shown. After the desired data have been recorded in this manner, the punched cards can be sorted into "Age," "Naturalized," or other groups and run through the machine again for a cross classification. But before this work is started it is necessary to substitute another curtain marked with the correct set of symbols.

In addition to the parts described, the mechanical brain also has four Burroughs desk calculators with fourteen columns each. The purpose of these is to accumulate amounts, and the combined additions of the 56 columns can be divided at will to take off as many of the cumulative totals as they will handle. The calculators are actuated by air plungers, one over each key of the machines. The figures, which are represented by holes punched in a card, are transferred both to the calculators and to the Veeder counters, so that a double entry is made. In this way every total can be checked—a feature which, according to the patent holders, no other machine of the type embodies.

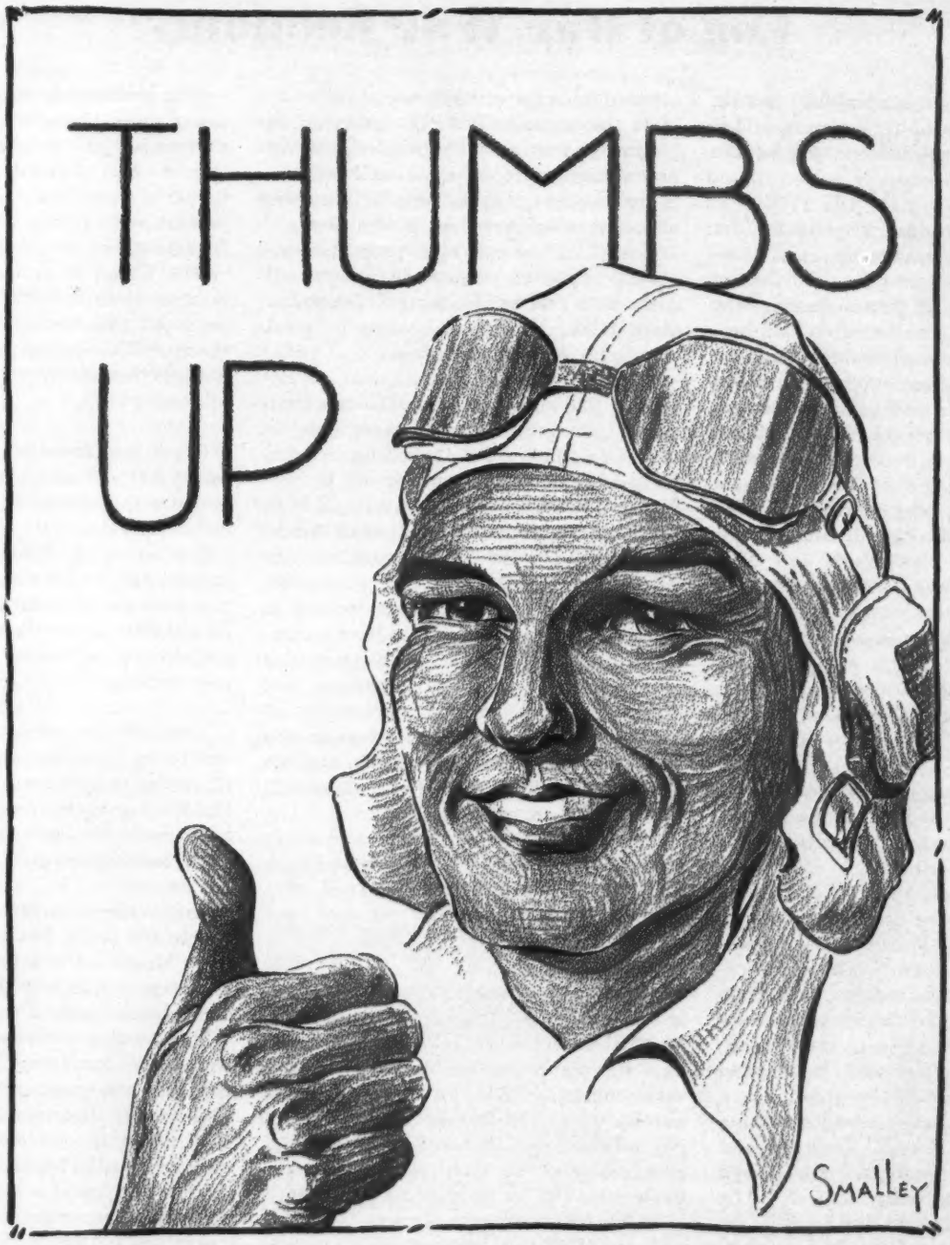
It is said that the nearest approach to the tabulator is one used in Washington, D. C., that gives 60 totals at once. By contrast, Mr. Belisle's mechanized brain provides 546, as we have already mentioned, in addition to the cumulative sums of the Burroughs calculators. The ingenious machine is the fruit of Mr. Belisle's perseverance, which he combines with an unusual talent in the field of mechanics. During the year 1928, he recognized that the electrical tabulators which were then used by the Dominion Bureau of Statistics had certain weaknesses. Specifically, they were sometimes guilty of short-circuiting, and when this took place they made gross errors in recording the statistical data. It was Belisle's idea to replace the electrical machines with compressed-air-operated devices. If air power could be used, there would, of course, be no opportunity for short-circuiting.

In his own time he began his experiments. When satisfied that he was approaching the problem correctly, he applied for and received both Canadian and American patents. Later, he made a working model and demonstrated it before his superiors in the bureau. They were so impressed by it that they directed him to build several machines. These have vindicated his hopes and have given practically trouble-free service. Despite their success, Belisle states naively that "I have a lot to learn . . . because I am yet a novice at it."



CENSUS POPULATION CARD

Each of the 26 holes punched in the card records salient information about one Canadian resident and was gathered by a field worker. A stack of these cards can be run through the mechanical tabulator at the rate of 250 per minute. Each hole allows compressed air to pass through it and thence, via tubing, to a plunger that actuates the associate counter by means of a pawl. Thus the various data are quickly tabulated for any political subdivision or for the entire dominion. On any one of the several kinds of cards used may be shown as many as 240 different facts, and the cards can be sorted, as desired, for cross tabulation.



Somewhere behind him
Home fires burn,
A village nestles
Around some turn,
A white house slumbers
Behind some hill,
Where the days, and the weeks,
And the months stand still.

Somewhere behind him,
Soft and sweet,
A hallway listens
For boyish feet,
Where a mother waits
For a lad's return,
Somewhere behind
Where the home fires burn.

Oh the world lies wide!
And the world lies round!
Bangkok, Burma,
Or Iceland bound;
Above the clouds,
Or beneath the sea,
He won't be back
'Till the world lies free!

Thumbs up, Mother!
Thumbs up, Dad!
Keep a door ajar
For a soldier lad,
In your own white house
Behind some hill,
Where the days, and the weeks,
And the months stand still.

—Carey Holbrook

Log of Our War Economy

THE following paragraphs contain significant bits of information culled from official press releases sent out by the War Production Board.

MAY 27—Stating that we cannot honor our heroic dead by taking holidays, Donald M. Nelson called for full production on Memorial Day in all plants making war goods or essential articles for civilian use.

The WPB announced plans to speed up the conversion of goose and duck feathers into grades of down and feather mixtures suitable for use in military sleeping bags, pillows, etc. Goose body feathers more than 4 inches long, duck body feathers more than 3 inches long, and tail and wing quills were released for civilian use.

Eight firms in New York and New Jersey that hold war contracts were ordered to stop discriminating against applicants for work because of their race or religion.

More than 500,000 jobs in factories, shipyards, and offices were filled in April by the U. S. Employment Service.

MAY 28—A ceiling price of less than $5 was predicted for the stirrup pumps that are to be manufactured to specifications drawn by WPB for the Office of Civilian Defense. These hand-operated pumps are used for extinguishing fires started by incendiary bombs and it is proposed to produce 2,258,000 of them. The specifications have been submitted to more than 300 firms, and some of them have already indicated their willingness to start manufacture. The stirrup pump will look a good deal like an automobile tire pump.

Chemical cotton pulp, used for making smokeless powder, rayon, plastics, and other important products, was placed under complete allocation control. The material is pure cellulose and is made by treating cotton linters. Wherever possible, high alpha-sulphite wood pulp will be substituted for it for nonmilitary application.

At the request of WPB, American engineering societies will hold a series of war-production conferences to exchange information that may be helpful in solving manufacturing problems in war plants.

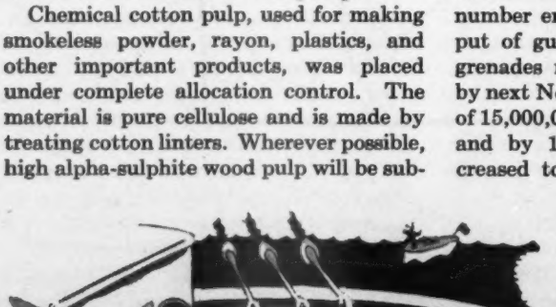
Leo T. Crowley, alien-property custodian, seized 80 patents owned by Japanese and two by Germans. Several of them relate to the processing of steel, aluminum, and other metals.

MAY 30—Three new Government-owned aluminum plants were put in service in May, a fourth will begin operating in June, and four more will be producing by August 1. The seven, all built by the Aluminum Corporation of America, constitute the first expansion program and are being finished considerably ahead of schedule. They are located in seven different states and will have a combined capacity of 640,000,000 pounds a year. Plants in the second expansion program, also with an annual capacity of 640,000,000 pounds, will start coming into production about next December, and the ultimate scheduled output of aluminum will be reached early in 1943.

New machine tools, presses, and other metalworking machinery valued at $114,100,000 were shipped during April, representing an increase of 72 per cent over April, 1941.

JUNE 1—Reviewing the war's manpower requirements, Administrator Paul V. McNutt set forth the following: To produce the planes needed, our airplane factories must, by 1944, hire four times the number employed last January; our output of guns, bullets, shells, bombs, and grenades must be multiplied five times: by next November we must have an army of 15,000,000 workers in our war factories, and by 1944 the number must be increased to as much as 20,000,000. To meet our goals, we will need 10,000,000 more war factory workers and 2,500,000 more Army and Navy personnel. It is planned to draw 7,000,000 to 9,000,000 of these from peacetime industries, 400,000 to 600,000 from farms, 400,000 from the ranks of professional men, 1,500,000 from the unemployed, and 2,000,000 from among housewives, youths, older workers, and others not now listed as a part of our regular labor force.

Maximum prices for 1942 fall styles of women's, girls', and children's cloth outer garments were set at the highest charged last fall for articles of substantially equal quality and workmanship.



"Quick! Let me have your diving gear. Here comes that bill collector again."

The production of musical instruments using more than 10 per cent of critical materials by weight was prohibited. Stocks of 27 different instruments in the hands of manufacturers, wholesalers, and jobbers were frozen and will be reserved for sale to the armed forces.

The Office of Defense Transportation postponed until July 1 the enforcement of its order that trucks operated in "over-the-road" deliveries must carry a load not less than 75 per cent of its capacity on all return trips.

JUNE 3—The alien-property custodian seized 600 patents owned by Germans and Italians and will make them available for use in this country.

During April, 7,500 physically handicapped men and women were put to work in numerous war industries. Approximately 400,000 partly disabled persons have so far been registered at public employment offices.

JUNE 6—To conserve steel, new pails can be used by the paint industry only to fill orders carrying a high priority rating. In all other cases reconditioned pails will be utilized. To prevent unwarranted price rises, maximum resale values have been set on old 2-, 3-, and 5-gallon-capacity pails. Without covers, these range from five to ten cents, but the inclusion of the cover doubles the price. After being reconditioned, the same pails bring from 31 to 45 cents each.

Tin entering into products listed as noncritical was cut an additional 10 per cent, reducing the permissible quota for the three months beginning July 1 to 30 per cent of the amount consumed in the corresponding quarter of 1941. In addition, the use of tin was prohibited in 28 classes of products ranging from advertising specialties to toys.

JUNE 8—To alleviate a shortage of cold-drawn, seamless steel tubing, users of that product were asked to employ substitutes wherever possible.

Canners of fruit, fish, and vegetables are considering further curtailing the use of tin, experiments having shown that chemically treated black steel plate is satisfactory for the ends of cans for packing specified commodities. It is also proposed to substitute electrolytic tinplate for hot-dipped tinplate in making the ends of cans for another group of foods, principally vegetables. The aim is to reduce the annual consumption of tin in the manufacture of cans to about 12,000 tons a year, as compared with 36,000 tons used last year.

The maximum price of the new Victory-model bicycle, which is expected to supplant the automobile to a considerable extent, has been set at $32.50 in the East,

$33.50 in the mid-continent, and $34.50 in the West. Of the previously frozen stocks of standard bicycles, 10,000 have been released for sale to war workers. Employees of Douglas Aircraft Company at Santa Monica, Calif., will get 5,766 of them.

JUNE 9—Shipments of steel plates from mills in May amounted to 1,012,194 tons, or 106,223 tons more than in April. Of the total, in excess of 300,000 tons went to shipyards. Nearly half the May tonnage was produced by continuous strip mills that were converted to plate-making.

JUNE 10—The President created a Combined Production and Resources Board to control the distribution of scarce materials to manufacturers. The first materials to be affected will be metals. All concerns using more than $5,000 worth of basic metal in a calendar quarter will, beginning July 1, have to obtain authorization for their requirements quarterly. Exceptions will be made in the case of a few special classes of companies, such as those engaged in transportation, construction, mining, and public-utility services.

JUNE 11—Construction of a 550-mile, 24-inch, crude-oil pipe line between Longview, Tex., and Salem, Ill., was approved. The line, which will require 125,000 tons of finished steel, will be completed by December 1, and will alleviate the oil shortage in the East.

JUNE 12—The old oaken bucket may stage a comeback. A limitation order requires a 30 per cent reduction in the use of iron or steel for metal pails and tubs but sets up no restrictions on the manufacture of wooden tubs and pails that utilize metal for hoops, bails, cars, and handles, provided the total weight of the metal is not more than 15 per cent of the article.

Laboratories engaged in research work not related to the war effort will no longer be able to get scientific equipment without approval of the Director of Industry Operations. The order will affect 3,000 laboratories, including those in colleges.

JUNE 14—Restrictions on the manufacture of baby carriages, effective August 1, are expected to cut the annual consumption of steel from 14,000 to 3,000 tons. Six of the 25 companies in the business expect to bring out models built of wood save for axles and fittings.

JUNE 15—During May daily war expenditures averaged $148,200,000, a gain of 10 per cent over the April rate.

The use of critical materials in electric-light bulbs was curtailed, but manufacturers were given authority to increase their 1941 production of incandescent and fluorescent lamp bases by 25 per cent. No advertising, Christmas-tree, or display lamps can be made.

Workers who devise means for more or better war production will be given awards of merit. There will be three classes, of which the highest will be signed by Donald M. Nelson, chairman of the War Production Board.

The publishing industry was given up-to-date information on the availability of the materials it needs. So far, paper is plentiful, but transportation stringencies may curtail delivery by fall. Ink also is available. Copper, zinc, and tin for type and printing plates are restricted, and no rubber is obtainable, except where absolutely essential. The sale of printing machinery valued in excess of $200 is under control.

JUNE 16—Stocks of new adults' bicycles which are soon to be rationed, totaled 150,668 units on May 8. Of these, 114,008 were for men and 36,660 were women's models.

JUNE 17—Plans have been announced for a nationwide campaign to save household fats, which amount to 2,000,000,000 pounds annually. Neighborhood food stores and meat markets will be asked to serve as collecting agencies and will pay housewives for such fat. As supplies accumulate, they will be sold to renderers, who will process them and forward the refined product to industrial centers. The chief need for fats is to serve as a source of glycerine, which has various important war uses.

JUNE 18—To feed the armed forces and civilians in the United Nations our farms will this year have to provide the following quantities of various commodities over and above the 1941 production: 9,200,000,000 pounds more milk; 430,000,000 dozen more eggs; 10,000,000 more hogs; and 3,000,000 more acres of peanuts. The latter are needed to replace oil that we used to get from Japan.

Donald M. Nelson appealed to union loggers on the Pacific Coast to forego vacations this year and urged owners and operators of lumbering plants to increase production as much as possible. Output is below last year's mark because of a scarcity of skilled labor, high labor turnover, and unfavorable weather.

JUNE 22—To keep the nation's 5,000,000 motor trucks operating as long as possible, all owners and drivers, as well as manufacturers, dealers, garages, and mechanics, are to be enrolled in a voluntary organization called the U. S. Truck Conservation Corps. A booklet containing suggestions for maintenance is to be distributed, and accompanying it is a pledge that all truck owners are urged to sign. Those who do so will receive an insignia for display on the right-hand door of the cab.

WAR FACTS
DRAWN BY BOB GLUECKSTEIN
SOAP
GLYCERINE
XXX DYNAMITE
IN MAKING 10 POUNDS OF SOAP ENOUGH BY-PRODUCT GLYCERINE IS OBTAINED TO PRODUCE 6 POUNDS OF DYNAMITE.
FOUNTAIN PENS AND AUTOMATIC PENCILS LAST YEAR USED UP 2,800 TONS OF STEEL — ENOUGH FOR 430,000 SHELLS FOR 75 MM FIELD GUNS.
WE MUST BUILD THREE SHIPS A DAY THIS YEAR AND NEXT TO COMPLETE OUR WAR TIME MERCHANT SHIP PROGRAM.
EVERY GASOLENE-LADEN TANKER SUNK DEPRIVES 5,000 AUTOS OF FUEL FOR A YEAR'S NORMAL DRIVING

Power and the War

ONE encouraging aspect of the war-production program is the absence thus far of any serious power shortage. It is encouraging because electric energy at home is vital to military success abroad. As has been stated here before, money alone will not win battles. Before it can be put to use it must be converted into munitions and supplies, and these cannot be turned out without power.

John C. Page, Commissioner of the Bureau of Reclamation, has reported that experts agree that for every dollar expended in the war effort, 2¾ kw-hrs. of electricity are required for the production of materials. On this basis, the $56,000,000,000 that the President says we will spend annually to bring about victory calls for the utilization each year of 154,000,000,000 kw-hrs. of energy. This is more than our total generation for all purposes in 1940. To emphasize the importance of power, Mr. Page cites that 220,000,000 kw-hrs. are needed to build a single large battleship and 637,000 enter into the production of a flying fortress.

A spokesman for the Federal Power Commission stated last fall that the countries Hitler then controlled had 200,000,000,000 kw-hrs. of electrical energy at their disposal. Since then, Japan has contributed probably 40,000,000,000 kw-hrs., making a total of 240,000,000,000 kw-hrs., which exceeds our 1940 production by 96,000,000,000 kw-hrs. It is apparent, therefore, that we cannot afford to be complacent about the situation. And it hardly needs to be added that concrete steps are being taken to bolster our power resources. The TVA and the Bureau of Reclamation are making splendid headway on their vast hydroelectric programs. Public power-generating agencies and all the private producers have likewise been increasing their facilities at a fast rate. Furthermore, interconnecting lines have been built to pool the resources in various areas, and through these it is possible to feed vast blocks of energy to manufacturing centers.

In normal times it takes as much as two years to construct a steam power plant, but short cuts have been established and in some instances new and old machines have been combined to do the job. For example, a used turbine from Detroit and boilers from Texas oil fields were hooked together to provide vitally needed power for the production of magnesium from sea water on the Gulf Coast.

Entering into the picture also is the floating power station. Generating units are being erected on barges that can be towed along the seacoast or through inland waterways to serve as boosters for stationary plants. They are under the control of the War Production Board and will be assigned to service where most needed. The adoption of War Time throughout the country, the turning out of display signs, the dimming of store lights, and care in extinguishing house lights when not in use have released an enormous amount of electrical energy for actual war production.

Wartime Publicity

TRADE journals have a definite duty to perform in wartime. Within the industries which they cover they can disseminate valuable information regarding new products, new processes, and short cuts that will serve to increase output. The "know how" that a factory in New England has developed might enable similar plants on the Pacific Coast and elsewhere to operate more effectually, to improve their products, or to reduce labor requirements and thereby release valuable manpower for other work.

Muzzling business and technical publications by censorship lest the enemy be aided is an erroneous theory. No one realizes this better than the Government technologists, and they are, accordingly, encouraging trade papers to make their pages as informative as possible. The matter of preventing the enemy from profiting from such publicity is being effectively handled through an export-licensing system under which all technical matter is reviewed and its distribution controlled.

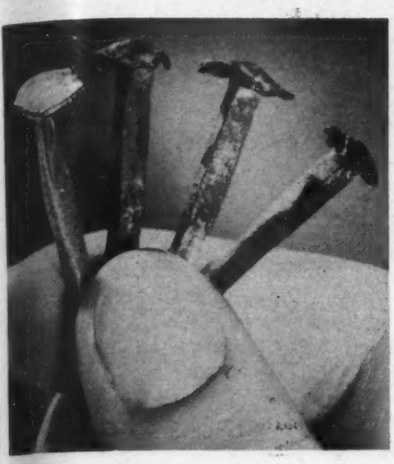
In line with this policy of rendering as much help to industry as possible, we will from time to time present articles that are designed to increase the war effort. Shortage of machines and materials, and accelerated operating schedules, place emphasis on maintenance so that existing equipment will keep functioning properly and its service life will be prolonged. "How to get the most out of it" will therefore be the theme of some of these articles. There is one in this issue on air-operated tools.

Base Metal Mining Policy

STRANGE as it may seem, the war is at one and the same time increasing the output of many base metal mines and adding to their productive lives. This seemingly anomalous situation is attributable to the fact that many properties are now working low-grade ore bodies that are ordinarily unprofitable.

The prices of lead, zinc, and copper have risen appreciably, but not spectacularly. They are pegged at certain levels, but premiums are paid for quantities in excess of the 1941 output. Offhand it would appear that mines might adopt a selfish attitude and bolster their premium payments by producing as much ore as possible from the highest grade deposits available. But a little reflection will make it plain that this policy would result in stripping the mines and thus make it impossible for them to operate profitably when prices return to normal levels.

Well-managed companies are taking advantage of the opportunity to balance their production between low and high grades to obtain an average ore that will yield a moderate profit. Since many mines have easily accessible low-grade deposits that have been passed over in former years as being too lean to warrant extraction, the quickest way to increase output is to work these areas along with some of the richer ones.



290-Year-Old Nails

Wrought-iron nails taken from Smith's Fort Plantation, reputed to be the oldest brick building in Virginia, are in a good state of preservation after 290 years of service. Three of them are seen at the right in the picture above. For the purpose of comparison, a new nail (left), patterned after the old ones, was made by the Tremont Nail Company of Wareham, Mass., one of the few manufacturers still producing wrought-iron nails. They are staging a comeback now that steel wire is conserved for more pressing uses. It will be noted that the heads of the Colonial nails show some wear but that their bodies are apparently free from corrosion.

Air-Conditioned Cabs for Cranemen

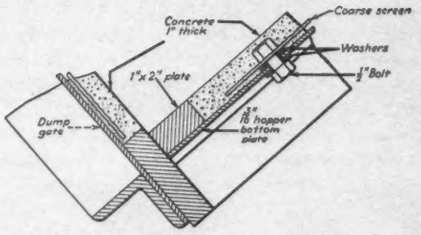
CONSIDERATION for the comfort and safety of the crane operators in its converter building has prompted the American Smelting & Refining Company, Garfield, Utah, to air condition the cabs. So protected from smoke and fumes, the men need not resort to gas masks nor respirators. When the system is in service, about 450 cfm. of air passes through filters and thence through activated-carbon odor absorbers to remove SO_2. It is next cooled by mechanical means and circulated through the cab. Since the rate of flow remains constant, a complete change of air occurs every two minutes.

In order to keep out smoke, a pressure slightly above atmospheric is maintained in the cab. During the summer months, the temperature inside is 10 to 15° lower than that on the outside, and in winter the air is kept comfortably warm by an electric heater. Thus the operator is protected not only from dangerous fumes but from extremes of heat and cold as well. The cab is inclosed in safety glass and is insulated with a 2½-inch thickness of rock wool. Among the equipment included in the conditioning system are two 20x20x2-inch air filters, two odor-absorbing units which must be reactivated every 90 days, a small air compressor driven by a 2-hp. motor, a cooling coil, a blower, and a 2,000-watt electric heater.

Ore Cars Lined with Concrete to Save Steel

PRIORITIES and the need of conserving steel caused the Britannia Mining & Smelting Company to experiment with concrete as a lining for its 20-ton hopper-bottom ore cars. In place of the customary ⅜-inch steel plate, a 1-inch-thick coat of concrete was tried with such good results that that material is now also used as a substitute for both steel and rubber in lining launders. The test car, other than slight wear through abrasion, showed no signs of cracks after handling crushed ore for a period of more than five months.

In making renewals, coarse screening, discarded in the mill's crushing plant, is fastened to the bottom plating with ½-inch bolts, as shown in the accompanying sectional drawing, and a piece of steel bar material is bolted across the bottom of the hopper to take the closing impact of the gate. The concrete—a mixture of pea gravel and 50-50 sand and cement—is poured over the screen, tamped, and given a smooth finish by troweling. The life of the lining is said to be several times that of steel and, in addition, rust ceases to be a factor.



Courtesy, Engineering and Mining Journal

STRUCTURAL DETAILS

Concrete instead of steel is used by the Britannia Mining & Smelting Company to reline its 20-ton hopper-bottom ore cars with air-operated dump gates.

Mobile Optical Shop for Overseas Service

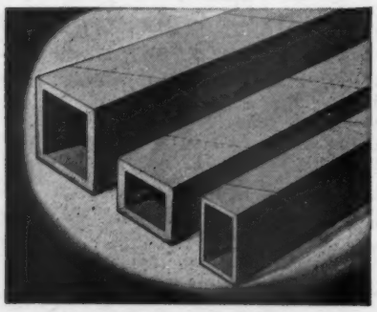
IT MAY not be generally known that an optical shop was set up in a suburb of Paris during the first world war to take care of the needs of the American Expeditionary Force. It was satisfactory so far as the character of its work was concerned, but the service was not quick enough because of the remoteness from the battlefronts. As a result of that experience the U. S. overseas field armies will be equipped with mobile optical shops, such as the one shown here. It was built by the American Optical Company and is the first of its kind. The unit was designed under the direction of Turner Wells, secretary of the company, at the request and with the aid of the U. S. Surgeon General's office and carries sufficient machinery and supplies to take care of the average requirements of a field army of 300,000 men. With approximately 15 per cent of the men in our armed forces wearing glasses, the shops will have plenty of work to do, and soldiers who have broken or lost their spectacles will be fixed up in short order.

GIVES QUICK SERVICE

This optical shop on wheels is commanded by Capt. J.R. Harrison (seated) and is completely equipped to edge and to mount 120 single lenses daily. The unit carries 36,000 lenses, 8,400 frames, 600 pairs of extra temples, and 1,200 spectacle cases. This picture is released for publication by the U. S. Government.

Industrial Notes

Dielectric paper tubes of an improved quality for electric coils are being manufactured by the Precision Paper Tube Company by the aid of a specially adapted heat die machine. They are made the same as heretofore of kraft or fish paper, or a combination of both, which is spirally wound on a steel die by automatic equip-



ment. After reaching that stage they are now pushed pneumatically through the new apparatus, where they are heat treated and compressed an additional 10 per cent. As a result, the tubes can be held to a tolerance of 0.002 inch, are stronger and more resistant to collapse, have superior dielectric properties and a lower moisture-absorption rate, and provide greater winding area. They are available in round, oval, square, and rectangular cross section and in continuous lengths of any diameter and wall thickness.

For opening metal drums up to 35 inches high, the Turner & Seymour Manufacturing Company is offering a device that works on the same principle as the kitchen can opener. When properly adjusted, the operator turns a handle and the tool does the rest.

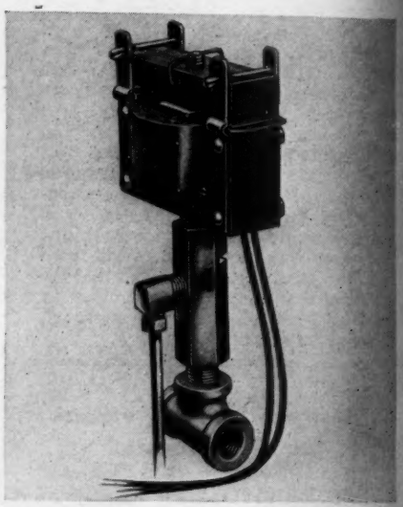
In line with the present need for conservation of strategic materials, Alden Products Company, Inc., North Main Street, Brockton, Mass., is turning out wire of 18, 20, and 22 gauge that has no rubber in its insulation. The product is available in any color or combination of colors to industries with priorities. A sample piece will be sent upon request.

Protective Coatings, Inc., is offering a water-white transparent fluid for the protection of valuable or much-used papers, drawings, blueprints, maps, etc. It is applied by brushing, dipping, or spraying and, when dry, forms a strong, flexible film that is said to be impervious to moisture and acids. One gallon of the liquid is sufficient to cover 150 square feet of paper on both sides.

Emergency safety equipment designed for wartime use by industrial and municipal public-safety departments is described and illustrated in an 8-page bulletin of the Mine Safety Appliances Company, Pittsburgh, Pa. Many of the items listed are identical with or similar to those the company has been furnishing for mine, construction, and industrial workers. Others have been developed especially to meet wartime needs. The bulletin, G-5, may be had upon request.

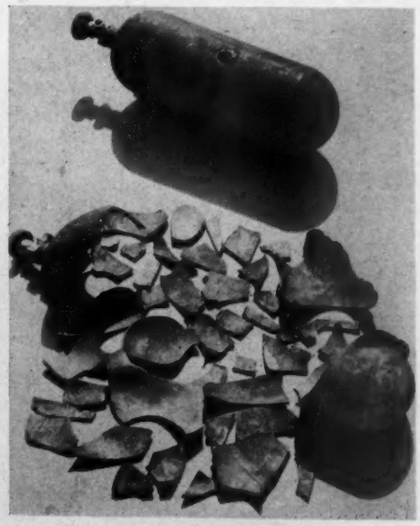
A considerable number of our advertisers has been honored by the Government for excellence of performance in turning out war materials. Among the latest awards bestowed was the presentation of the All-Navy "E" to the National Forge & Ordnance Company, Irvine, Pa. This follows the Navy "E" award made last fall, and is in the nature of further recognition of outstanding work done by that concern.

Electromagnetic-pneumatic and direct-pneumatic control of packless air valves is serving to increase the application of air power in the field of machine operation, according to The Prosperity Company, Inc. Its Industrial Valve Division is featuring Lok-Air packless valves and air-control systems which are finding favor with operators of forges, punch presses, metal shears, breakers, etc., because of their 2-hand or safety control and which are making it possible to do with compressed air work now done manually, by foot, or by steam or electricity. A hex-type pilot valve is the key to the system. Through it, compressed air is admitted to a master valve assembly which, in turn, feeds air from the main line to a power cylinder. The pilot valve is designed for direct control of well-nigh any kind of air hook-up, while remote control is effected by the electromagnetic-pneumatic valve shown in the accompanying illustration. The latter is actuated by a pushbutton switch through the medium of an electromagnet of which the hexagonal valve forms an integral part. Lok-Air valves are said to be leakproof and to assure positive action; power application is instantaneous or graduated; acceleration or



deceleration of movement is accomplished by means of a Lok-Air cylinder and accessories; clutches may be eliminated; and designs that usually require multiple levers and cams can be simplified. By combining the patented Prosperity Formatrol Cycle Timer with the valves, multiple functions can be controlled automatically from an adjustable master record. We are informed that this apparatus insures an unvarying sequence of operations each timed to the split second. In a laundry washroom, for example, a unit of this type governs 45 distinct functions in one hour or more of elapsed time, as required. Delayed-action and piston-type timers, designed to control single operations for periods ranging from 5 to 60 seconds, also are available.

Polished metal surfaces can, it is said, be made to look like copper, brass, bronze, etc., by Platelustre developed by Maas & Waldstein Company as a substitute for electroplating and bronze-powder finishes. The material, a concentrated enamel, is added to clear lacquer and applied by spraying or roller coating. It is available for either air drying or baking, and permits of 2-tone effects. The colors are fast, provided the metals are used indoors.



SHATTERPROOF

Like the fuel tanks of airplane engines, the pressure cylinder shown at the top of this picture will not break into pieces when struck by a bullet. The latter will puncture the steel shell, but other than that the flask will remain intact. It is made by Walter Kidde & Company especially for airplane use and for carrying oxygen at 1,800 pounds pressure, but can be utilized for dispensing other compressed gases. Capacities range from 11 to 63.7 cubic feet. The fragments show what happens to an old-type cylinder when hit by a bullet.

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